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Final Technical Report
December 1977

ADVANCED COMPILATION TECHNIQUES

M. Lynn Taylor
Kathryn S. Przewlocki
Patricia A. Watson

PRC Information Sciences Company

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ROME AIR DEVELOPMENT CENTER
Air Force Systems Command
Griffiss Air Force Base, New York 13441

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APPROVED: John R. Baumann

JOHN R. BAUMANN
Project Engineer

APPROVED: Howard Davis

HOWARD DAVIS
Technical Director
Intelligence & Reconnaissance Division

FOR THE COMMANDER: John P. Huss

JOHN P. HUSS
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A design specification for development of an experimental batch compilation system is presented in this report. This design specification defines the system requirements, design concepts, and software functions for the batch compilation system. The effort included analysis of compilation processes and batch processing requirements, feasibility analysis of compilation functions in a batch processing environment, and the functional design specification. Manipulation of the digital cartographic features has progressed through development of basic batch processes addressing a variety of compilation-related func-

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tions. Varying capabilities exist in both the research and production environments to perform coordinate transformation, extraction, sectioning, symbolization, and other functions. In most cases, standards, specifications, and mathematical definitions provide clear and definitive criteria for those batch processes developed to date. Analysis was directed towards a more complete, more automatic batch compilation system. A list of references is included in the Bibliography and a brief summary of existing systems which were examined is included. The next step towards development of advanced batch compilation functions is preparation of software development specifications for a designated computer system.

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EVALUATION

This effort was concerned with defining the functional characteristics of a cartographic compilation system which operates in a batch processing environment.

Implementation of the described system in an operational environment such as the Defense Mapping Agency Aerospace Center (DMAAC) will decrease the time required to produce a given chart from a digital data base and provide a more consistent product than can presently be obtained.

John R. Baumann

JOHN R. BAUMANN
Project Engineer
Image Products Section

FOREWORD

This final technical report was prepared by PRC Information Sciences Co., 7600 Old Springhouse Road, McLean, Virginia. The report covers work performed under Contract F30602-76-C-0323 for Rome Air Development Center, GAFB, New York. Mr. John Baumann was the RADC Project Engineer.

I. INTRODUCTION

A. Purpose and Scope

A design specification for development of an experimental batch compilation system is presented in this report. This design specification defines the system requirements, design concepts, and software functions for the batch compilation system. The effort included analysis of compilation processes and batch processing requirements, feasibility analysis of compilation functions in a batch processing environment, and this functional design specification. The next step towards development of advanced batch compilation functions is preparation of software development specifications for a designated computer system.

B. Background

Manipulation of the digital cartographic features has progressed through development of basic batch processes addressing a variety of compilation-related functions. Varying capabilities exist in both the research and production environments to perform coordinate transformation,extraction, sectioning, symbolization, and other functions. In most cases, standards, specifications, and mathematical definitions provide clear and definitive criteria for those batch processes developed to date. Analysis was directed towards a more complete, more automatic batch compilation system. Analysis of compilation processes, functional requirements and feasibility, and background developments provided the basis for this report. A list of references is included in the Bibliography and a brief summary of existing systems which were examined is included below.

- <u>Batch Processing System</u>

  The ACS Batch Processing System (BPS) is a modular system under strict user control. It provides sectioning, paneling, line smoothing, symbolization, and extraction functions, as well as others which are not of concern to this study. The BPS exhibits

good overall software structuring and control and should provide guidance in design of a batch compilation system.

- o <u>Graphic Line Symbolization System</u>

  The Graphic Line Symbolization System (GLSS) generates required lineal symbology and certain geometric point symbology, as well as performing line smoothing and resolution maintenance. The lineal symbology is relatively complete, although cased road intersections present problems. The point symbology is software generated, and thus more complex symbols are not available. Various line smoothing and resolution maintenance process options are also provided. The GLSS is modular and utilizes: a master specification file principle to determine symbology; user overrides to standard specifications; and techniques to allow independency from external I/O formats.

- o <u>Experimental Cartographic Console System</u>

  The Experimental Cartographic Console (ECC) - Cartographic Digitizing Plotter (CDP) software provides alphanumeric text positioning and point symbolization via an interactive system. The point symbology provides complex patterns which are maintained on a symbol library. Although placement is user directed rather than automatic, techniques utilized in rotation, scaling, and text spacing may be utilized in a batch compilation system.

- o <u>Lineal Input System</u>

  The Lineal Input System (LIS) is an on-line system with a batch processing capability. The sectioning, paneling, and file transformation functions are provided. Sectioning can be performed on either geographic or cartesian coordinate files. Up to an eight-sided section polygon is accepted, and either internal or external data is retained. Paneling is performed only on geographic coordinate files. The Data Access Management Subsystem provides a locational index scheme (for cartesian coordinate files), dynamic allocation of mass storage (disk), and file maintenance

functions. Features may be retrieved from a cartesian coordinate (indexed) file according to:

- Feature sequence number
- Feature data disk address
- Closest feature (within a selected grid) to a specified coordinate value
- Feature passing within a specified threshold distance from a designated point
- Closest feature (within a grid) to a designated point excluding a specified feature
- Closest point on a designated feature to a specified point

o Digital Navigation System

The Digital Navigation System appended to the LIS provides a line generalization capability via three different algorithms. These include the anchor floater, angle of delineation, and tangent limits methods.

o ACS Mod II System

The ACS Mod II System is written in the FORTRAN language and operates on the HIS-635 computer system. The functions supported by Mod II are: conversion (AIT-MMS) including clipping, closing, registration, smoothing, cleaning, and scaling; extraction, editing, symbolization, generalization, and paneling.

The control structure of Mod II was job oriented. Each performed a specific function. Multiple jobs were accomplished by modifying the control card so that output tapes were saved and used as input to the next job.

o Graphic Improvement Software Transformation System

The Graphic Improvement Software Transformation System (GIST) provides batch compilation capabilities including:

- Batch edit
- Clip/join
- Intersection location
- Coalescence shift
- Feature orientation

GIST is segmented into several levels, each accessing the structured data base and each level is accomplished as an individual run.

C. Summary

1. Objective and Technical Approach

The objective of the effort was twofold: (1) analyze and assess the feasibility of performing cartographic compilation functions in a batch processing environment; (2) and develop a design specification for a modular batch compilation system which includes those functional processes which were deemed feasible and represent significant value. Key elements of the technical approach for accomplishing the effort included the following:

- Coordination with RADC personnel concerning concept formulation and definition of the batch compilation environment.
- Collection of backgound information pertinent to batch compilation functions, processing techniques, capabilities, timings, etc.
- Analysis of compilation background and requirements and subsequent preparation of a project working paper titled "Batch Compilation Concepts and Requirements Analysis". This working paper provided a framework for the functional analyses and subsequent design specification.
- Detailed analysis of each of the functional requirements and assessment of technical feasibility. A project working paper, titled "Functional Analysis and Feasibility Study" was prepared and delivered to RADC for review and coordination.
- Development of a design specification for a batch compilation system which will provide a software base for implementing and testing key compilation design concepts and functional processes.

2. Technical Results

The feasibility analysis resulted in a detailed study and assessment of each compilation functional process. All of the compilation functions addressed by the study were viewed as technically feasible to some level. Several functions may present particular difficulties in

areas such as conflict detection/resolution and/or consume excessive resources. By grouping the functions according to the basic type of service provided, levels of complexity emerge. The process of automated compilation can be viewed as composed of four major areas:

- <u>Data Commonization and Reduction</u>

  This is the process of reducing and converting all source data to the common form required by the system. It includes elimination of all unnecessary data and performing all functions which can be achieved against a single feature. The functions falling within this area are:

  - Data Input
  - Scaling
  - Transformation
  - Sectioning
  - Resolution Maintenance
  - Line Generalization (no allowance for adjacent features)
  - Automatic Feature Culling (where the feature classification is the <u>only</u> criteria)
  - Area Feature Deletion (assuming user defined area)

- <u>Association Processing and Conflict Detection</u>

  This involves the recognition of feature relationships, such as intersections, coalescence, and proximity, which directly affects the course of action to be followed during the compilation process. It serves to identify the features (or feature segments) requiring modification. The more complex modifications, such as shifting, are performed within the next phase. The functions which may be included within this area are:

  - Feature Placement
  - Paneling
  - Automatic Feature Culling (including consideration of multiple feature relationships)

- Area Feature Deletion
- Coalescence Detection
- Automatic Contour Generation

o <u>Data Base Corrections/Adjustments</u>

This is the process of altering or replacing the appropriate features identified during the previous phase. The surrounding areas must be examined following each modification to insure that undesirable conflicts have not been created. This operation may require extensive resources and will require close experimental examination. The functions included within this area are:

- Coalescence Shift
- Coalescence Deletion
- Fitting Contours to Drainage
- Automatic Symbol Change

o <u>Compilation Finishing</u>

This final phase prepares the compiled chart for cartographer verification and for retention within a digital cartographic data base. The functions in this phase include:

- Symbolization
- Automatic Text Placement
- Paneling
- Proof Plotting
- Data Output

The resulting concepts and design specification embodies the development of a software system which will provide a basis for experimentation of advanced compilation techniques. All aspects of the system are geared towards demonstration of new techniques and allowances for subsequent additions, modifications, or improvements as the state of the art advances. The system design specification provides an expandable software control structure. Certain "key functions" are included in the system to provide a basis for verifying the feasibility of more complex batch compilation functions.

These "key functions" were selected on both their value to the compilation process and level of feasibility within an experimental system. The simpler functions and those which have been previously accomplished are allowed for in the design, although must not detract from the major concentration on the experimental "key functions". The compilation specifications for direction of software actions and the supporting data base are crucial to the flexibility of the experimental batch compilation system. As such, their design provides for expansion and/or modification while remaining specifically responsive to the functional requirements of the system. Thus, the "key functions", the data base structure, and the product specification file received particular attention and represent major design areas towards development of the experimental system.

PRC recommends implementation of the following functions in an experimental batch environment based on their potential value to advanced compilation processes and the fact that experimentation is warranted to verify their level of feasibility.

- o Automatic Feature Culling
- o Coalescence Deletion
- o Coalescence Shift
- o Automatic Type Placement

In addition to the above identified functions, certain other capabilities were included in the design specification because of their supplementary role in experimentation. These additional capabilities include:

- o Scaling
- o Resolution Maintenance
- o Line Generalization

D. Organization

Following this introduction, Section II presents the design specifications for the Advanced Compilation Techniques System (ACTS). Included in Section II are system requirements, design concepts, and software structure and processes. Appendix A is included which presents sample product specification information which will be required for each function. Appendix B presents a glossary of terms and abbreviations used throughout the report.

II. DESIGN SPECIFICATIONS

A. System Requirements

This section contains:

- o Conceptual environment in which batch compilation would reside.
- o Functional areas of the system, and the principal interfaces between each functional area.
- o Identification of the I/O and principal interfaces between the specified system and other systems with which it must be compatible.
- o Specific design constraints peculiar to each functional area.

1. System Environment

The chart production process is divided into the following phases:

- o Research - collection, maintenance and evaluation of cartographic source materials.
- o Compilation - selection of source materials and compilation of all cartographic feature information pertinent to the product purpose and requirements.
- o Color separation - final symbolization and drafting (engraving) of finished color separation negatives.
- o Printing and Distribution - final chart printing and dissemination to users.

The envisioned overall production environment, as defined within the Advanced Cartographic System (ACS) concept, basically conforms to these current production phases. As automated systems and techniques are developed and implemented, the phases of chart production will approach those of the ACS concept:

- o Source Data Acquisition and Processing
- o Cartographic Data Bank Generation/Maintenance
- o Source Exploitation and Product Compilation
- o Product Finishing and Reproduction

Figure II-1 illustrates the logical associations of the major production phases and identifies the major activities which are planned to occur in each phase. Identified below each phase is a list of automated systems which are currently operational and conceptually planned for the production environment. The Advanced Compilation Techniques System (ACTS) defined in this report is expected to operate within the bounds of the Source Exploitation and Product Compilation Phase.

2. System Purpose

The purpose of the Advanced Compilation Techniques System is to provide a wide range of compilation functions in a batch processing environment. The system functions will process data base source files and generate a batch compiled product file. This capability will reduce the burden and extent of compilation actions required by cartographers at interactive compilation stations.

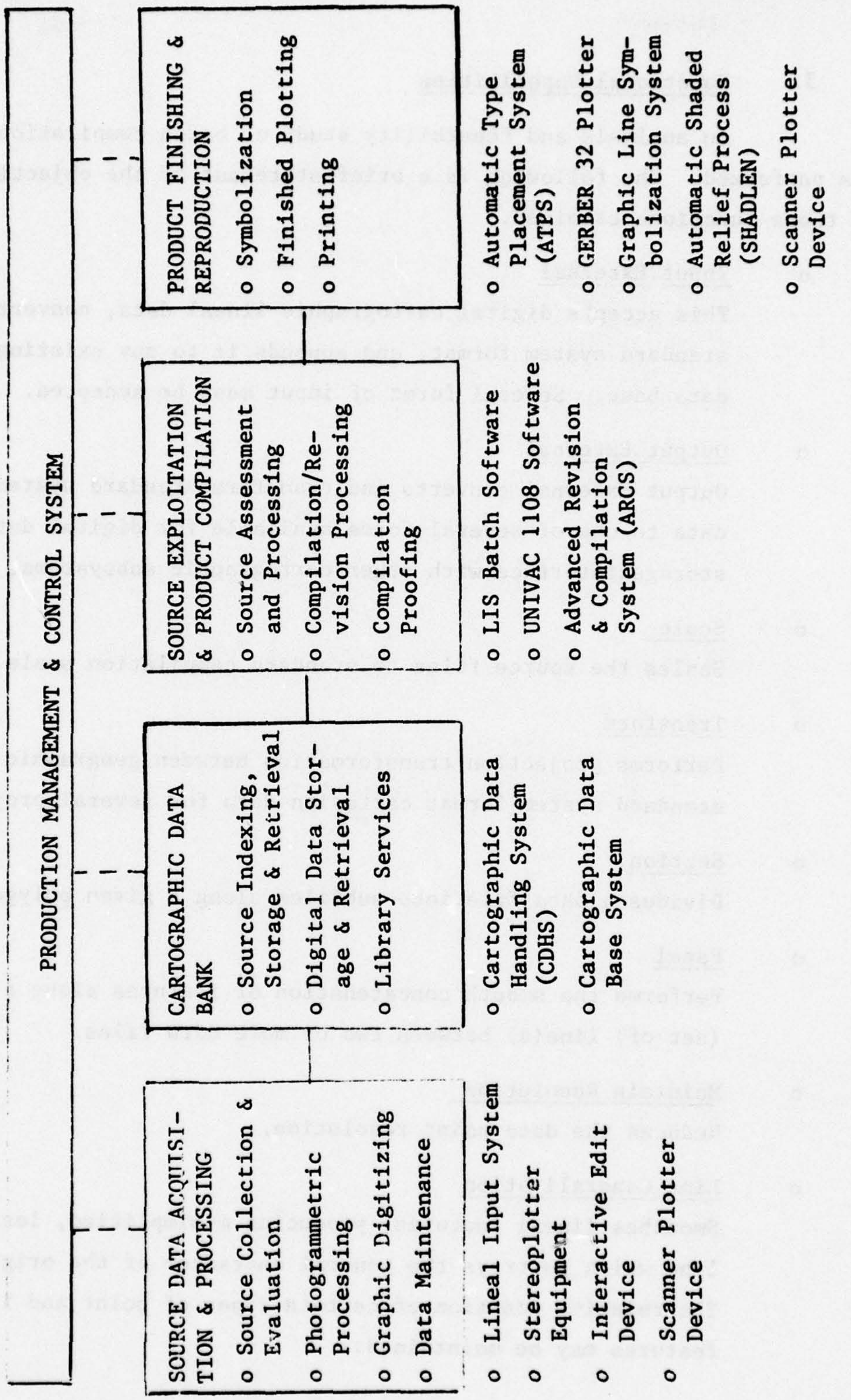

Figure II-1 ACS Concept and Operating Environment

3. Functional Capabilities

An analysis and feasibility study of batch compilation functions was performed. The following is a brief statement of the objectives of each of those functions examined.

- **Input External**
  This accepts digital cartographic lineal data, converts it to the standard system format, and appends it to any existing system data base. Several forms of input must be accepted.

- **Output External**
  Output External converts and transfers standard system format data to one of several forms available for digital data bank storage, interface with other cartographic subsystems, or plotting.

- **Scale**
  Scales the source files to standard compilation scale.

- **Transform**
  Performs projection transformation between geographic data and standard system format cartesian data for several projections.

- **Section**
  Divides a data file into subfiles along a given polygon boundary.

- **Panel**
  Performs the smooth concatenation of features along a given (set of) line(s) between two or more data files.

- **Maintain Resolution**
  Reduces the data point resolution.

- **Line Generalization**
  Smoothes lineal features, producing a simplified, less convoluted line which portrays the general character of the original feature. The relative position of certain types of point and lineal features may be maintained.

- Automatic Contour Generation

  This converts several forms of elevation data into lineal contours and spot elevations in the standard system format.

- Feature Extraction

  Deletes from the data base all features which, according to their classification, are insignificant to the product.

- Hold Point Annotation

  Provides for the retention of previously specified features or feature points within the data base.

- Feature Placement

  Locates and provides for the retention of feature intersections or junctions which are critical to the product.

- Automatic Feature Culling

  This deletes from the data base all features which, according to their classification, are insignificant to the product. Those features of importance due to their relationship with other features are recognized and retained.

- Area Feature Deletion

  Deletes from the data base those features which are insignificant to the product according to their classification, their relationship with other features, and the general chart subarea characteristics. The chart subareas are user defined.

- Coalescence Deletion

  Recognizes and deletes from the data base those features or feature segments which coalesce illegally with other features on the product.

- o **Coalescence Shift**

  Recognizes and adjusts those features or feature segments which coalesce illegally with other features.

- o **Fitting Contours to Drainage**

  Adjusts contours so that upstream undulations are properly aligned with the appropriate drainage feature. The relative position of contours to spot elevations and to other contours is maintained to preserve chart accuracy.

- o **Automatic Symbol Change**

  Recognizes and corrects feature symbology requiring modification due to a reduction in chart scale. This includes conversion from an area feature to a point symbol, and conversion of a group of point symbols to an area feature.

- o **Symbolization**

  Produces a properly symbolized version of the compiled feature data base.

- o **Automatic Type Placement**

  Places indicated text into the data base. The text is in the correct font, properly oriented, and does not conflict with other features.

A subset of these functions will comprise the Advanced Compilation Techniques System (ACTS) addressed in this document. Function selection was based on the following criteria:

- new or untried processes
- worth to overall batch compilation objectives
- extensive use of production specifications

Based on the above factors, the following functions were identified for experimental development:

- o Automatic Feature Culling - capability to detect and process complex feature relationships and extensive use of product specifications.
- o Coalescence Deletion - detection and examination of illegal coalescences and extensive use of product specifications.
- o Coalescence Shift - capability to modify data without generating subsequent conflicts.
- o Automatic Symbol Change - capability to detect feature portrayal characteristics and modify accordingly.
- o Automatic Type Placement - automatic selection, placement, and orientation of alphanumerics.

The following additional functions are required to format and reduce data, provide verification capabilities, prepare the data for the compilation functions, and to complement the above experimental functions. These include:

- o Input External
- o Output External
- o Scale
- o Maintain Resolution
- o Feature Extraction
- o Hold Point Annotation
- o Feature Placement
- o Line Smoothing

4. <u>Interfaces</u>

The Advanced Compilation Techniques System (ACTS) will conform to the Advanced Cartographic System concept. It will operate within the Source Exploitation and Product Compilation phase. Based on the role of the Advanced Compilation Techniques System and its various components, several interfaces with other manual and automated systems are required as illustrated in Figure II-2. Two general types of interfaces are currently defined.

- o Pre and Post-Compilation Interfaces
  - Data Bank Interface - consists of input of digital source information and associated source identification information and recommended usage.
  - Product Finishing Interface - consists of output of digital feature files and associated proof plots.
- o In-Process Interfaces - those interfaces which occur during the compilation phase and involve supplementary manual techniques or automated systems, such as:
  - Production management and control
  - Interactive compilation and proofing

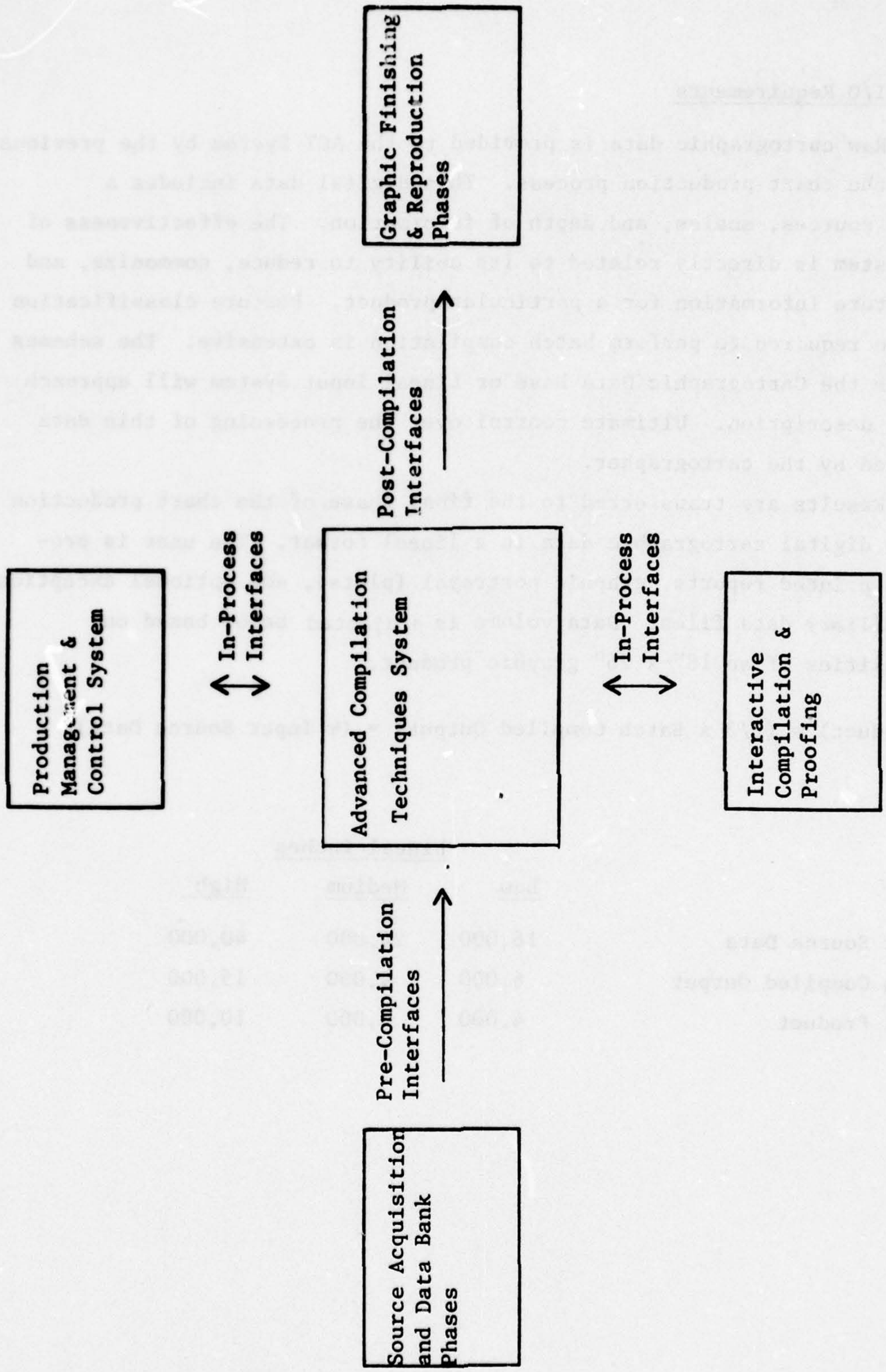

Figure II- 2 System Interfaces

5. I/O Requirements

Raw cartographic data is provided to the ACT System by the previous phases of the chart production process. This digital data includes a variety of sources, scales, and depth of information. The effectiveness of the ACT System is directly related to its ability to reduce, commonize, and select feature information for a particular product. Feature classification information required to perform batch compilation is extensive. The schemes utilized in the Cartographic Data Base or Lineal Input System will approach sufficient description. Ultimate control over the processing of this data is furnished by the cartographer.

Results are transferred to the final phase of the chart production process as digital cartographic data in a lineal format. The user is provided with printed reports, graphic portrayal (plots), and optional exception and/or auxiliary data files. Data volume is projected below based on sample densities of an 18" x 26" graphic product.

(Final Product) = (2/3 x Batch Compiled Output) = (¼ Input Source Data)

	Lineal Inches		
	Low	Medium	High
Input Source Data	16,000	24,000	40,000
Batch Compiled Output	6,000	9,000	15,000
Final Product	4,000	6,000	10,000

6. Design Requirements

The set of design requirements stated in the SOW were used as a baseline for this document. These include:

Software

- o Provide modular designed operating system to allow for ease of expansion and/or modification.
- o Provide that each function to be performed is addressed by a single callable module.
- o Allow the sequencing of modules so that any part of a complete compilation can be performed during a single run.
- o Modular design is to include considerations for the variable sequencing of tasks.

Hardware

- o Designed system shall operate on the HIS-6180 or HIS-635 at RADC and must include consideration for ultimate transfer to the Univac 1108.

Operation

- o System designed shall reduce the burden placed on the cartographer and the terminal station. This will result in placement of cartographers in their most effective role as reviewers of the batch processed digital feature data for correctness and completeness.

In addition, PRC has applied the philosophies of structured system design.

B. Design Concepts

1. Overview

The Advanced Compilation Techniques System is planned to operate in a batch processing environment and service a wide range of users. The user will provide digital source files or identification of required files that are possibly maintained on mass store devices. The software will interpret user instructions and access Product Specification Files for compilation directives. Appropriate software processes will be applied to digital feature data and compiled feature information will be output for further compilation plotting and proofing. The software will maintain all pertinent processing statistics and error conditions and will generate a job report for user review and verification. A basic operational flow of the major components of the system is presented in Figure II-3. This section discusses design concepts for major components of the proposed experimental system design.

2. User Inputs

The system user will typically be responsible for defining several types of information pertinent to the job execution. Types of information might include: data base source file names, type of compilation job and/or specific processing functions to be exercised, processing parameters for each function (if applicable), Product Specification File to be applied, and types of output required.

The above list of user inputs is not intended to impose unnecessary inputs from the user, although certain jobs are anticipated to require somewhat definitive direction from the cartographic user. We expect that "standard job run stream" techniques will be employed for normal batch processing jobs. Also, standard default values should be used where possible.

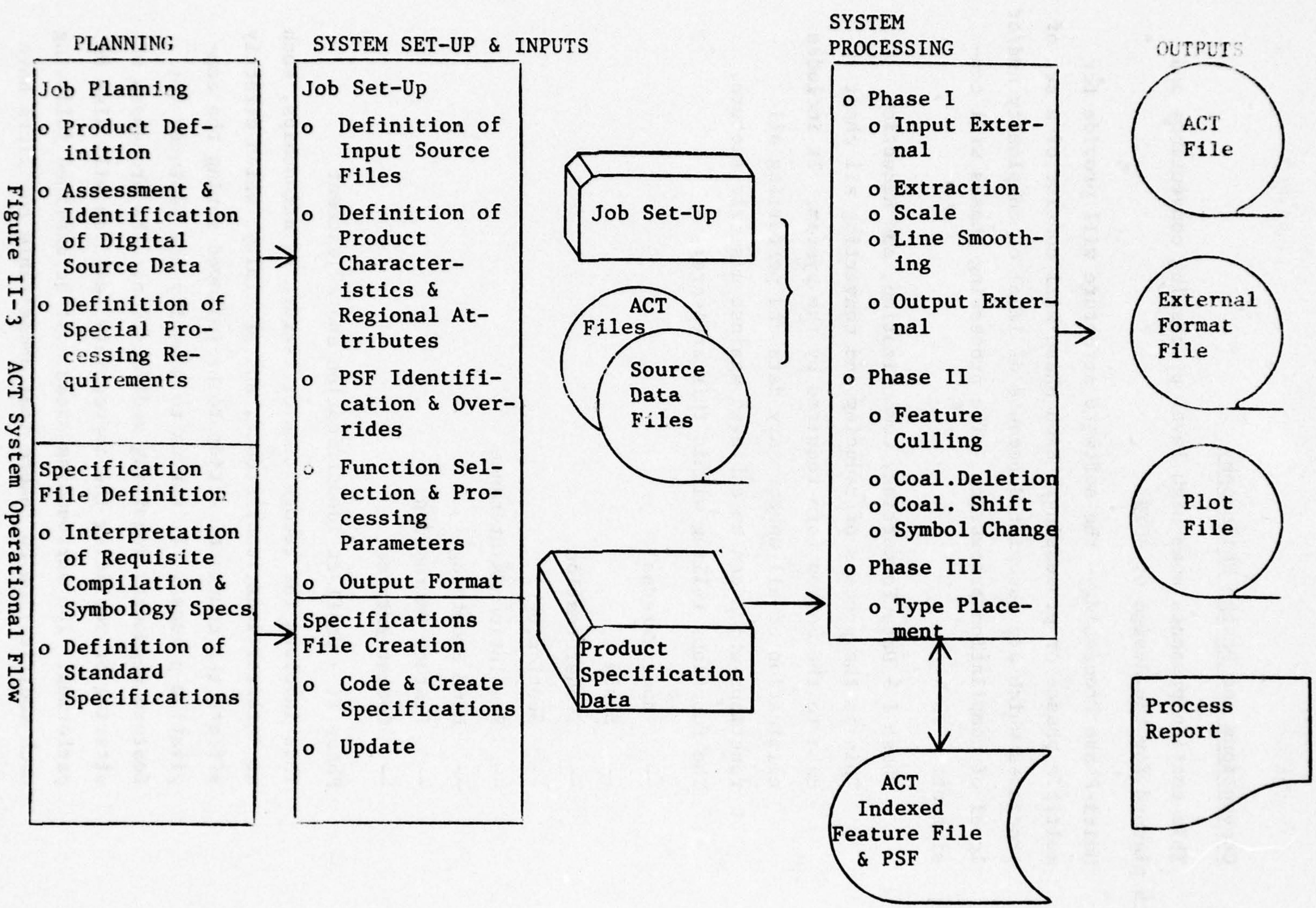

Figure II-3 ACT System Operational Flow

3. Conventions and Design Philosophy

This section presents some high level processing conventions and concepts planned for the design of ACTS.

- Multi-Phase Processing - the software structure will provide for multiple phases of processing. Each phase will consist of a set of processes which are associated because of level of complexity and/or level of compilation processing. The processing phases will consist of:

  - Phase I - Data Formatting, Commonization, and Reduction
    This is the process of reducing and converting all chart data to the common form required by the system. It includes elimination of all unnecessary data and performing all functions which can be achieved against a single feature. The functions falling within this area are:

    -- Input External
    -- Scale
    -- Transformation
    -- Sectioning
    -- Resolution Maintenance
    -- Line Smoothing
    -- Feature Extraction
    -- Output External

  - Phase II - Conflict Identification and Adjustment

    This involves the recognition of feature relationships, such as intersections, coalescence, and proximity, which directly affects the course of action to be followed during the compilation process. It serves to identify the features (or feature segments) requiring modification. The processes of altering or replacing the appropriate features will also be performed. The surrounding areas must be examined following each modification to insure that undesirable conflicts have

not been created. The functions included within this area are:

-- Line Generalization

-- Automatic Feature Culling

-- Area Feature Deletion

-- Coalescence Shift

-- Coalescence Detection

-- Fitting Contours to Drainage

-- Automatic Symbol Change

- Phase III - Compilation Finishing

This final phase prepares the compiled chart for cartographer verification. Feature relationships must be considered. The functions include:

-- Symbolization

-- Automatic Text Placement

-- Paneling

o Input/Output Commonality - the output format will be compatible with the input format requirements. This capability will permit partial compilation, review and proofing and re-entry of data files for further processing.

o Standard Internal Data Buffer - all applications functions will operate against a standard feature data buffer. This will permit independency of I/O formats, commonality of processing conventions, and ease of application of multiple functions to a resident feature.

o Structured Random Accessed File - design of the indexed file, employed for complex association processing, will consider compatibility with the structured file designed for interactive compilation stations. This concept could allow for direct use of the structured file by the batch or interactive systems.

o Compilation Rules and Guidelines - the batch compilation functions will require extensive sets of compilation directives. To allow for systematic creation and update these directives will be maintained in a Product Specification File separate from program logic.

4. Control Structure

The batch compilation design must provide a somewhat unique and flexible control and sequencing of processes. This situation exists because of the variety of functional processes required for batch compilation and the multitude of job types required for product compilation. To facilitate these requirements and the "phase processing concept" two levels of control are recommended. In general controllers will regulate the flow of functional processes and data. A "system controller" will control high-level processing between major phases; and individual "phase controllers" will direct all processing within each of the three functional phases. Figure II-4 illustrates the high level control structure.

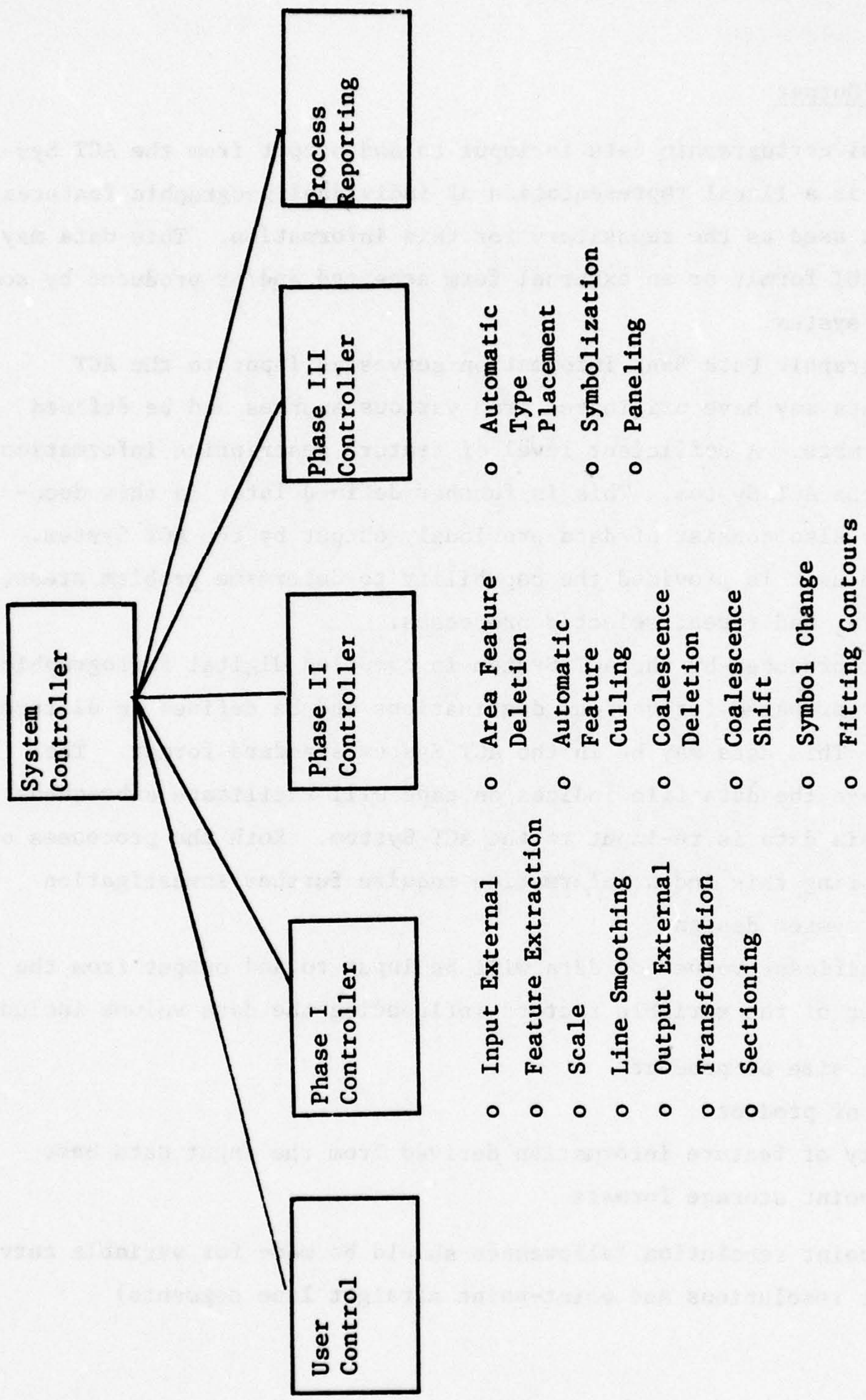

Figure II-4 Control Structure Chart

5. Input/Output

Digital cartographic data is input to and output from the ACT System. This data is a lineal representation of individual geographic features. Magnetic tape is used as the repository for this information. This data may be in standard ACT format or an external form accepted and/or produced by some other automated system.

Cartographic Data Bank information serves as input to the ACT System. This data may have originated from various sources and be defined in different formats. A sufficient level of feature descriptive information is required by the ACT System. This is further defined later in this document. Input may also consist of data previously output by the ACT System. Thus, the system user is provided the capability to determine problem areas, modify parameters, and repeat selected processes.

Output produced by the ACT System is compiled digital cartographic data. It may be prepared for various destinations and be defined in different lineal formats. This data may be in the ACT System standard format. The capability to save the data file indices on tape will facilitate subsequent processing if this data is re-input to the ACT System. Both the processes of saving and restoring this index information require further investigation during detailed system design.

A significant volume of data will be input to and output from the ACT System. Some of the variable factors influencing the data volume include:

- Format size of product
- Scale of product
- Density of feature information derived from the input data base
- Data point storage formats
- Data point resolution (allowances should be made for variable curvilinear resolutions and point-point straight line segments)

6. Data Base

a. Role and Services

The data base is a major component of the Advanced Compilation Techniques (ACT) system. It provides the capability to retain cartographic information in a digital form. Information stored in the data base must be comprehensive enough to support the data requirements of all pertinent cartographic products. Additionally, it will contain information providing system control.

The data base will provide an efficient method of storing, maintaining, and retrieving cartographic information. To achieve this, a sophisticated data management system will be developed.

The major role and purpose of the Data Management System (DMS) is to provide the software support interface between the applications programs and the data processed by these programs.

Fundamental to the design of the DMS is the establishment of the data contents of the feature files. In the context of this document data contents is independent of the storage structure (i.e., the way data is physically stored by the DMS). The *data contents of feature files* on the ACT System is discussed below. Each refers to a standard ACT System feature file format presented later in the document.

- o <u>Feature File</u> - This file will be in the standard ACT System feature file format. The file will consist of features represented by header/descriptors and feature segments (data lists). It will be able to be re-input to the ACT System for further exploitation processing. The use of this file form supports the concept of indexing only prior to functions where indexing is required to improve processing speed and feature accessibility.

- o <u>Indexed Feature File</u> - The Indexed Feature File will be in the standard feature file format and will have either or both a locational and descriptive index. This file will be utilized by those functions requiring an indexed file to facilitate their

processes. As with the Feature File, this file can be re-input to the system.

The features within either file are logically independent of one another. However, they will be explicitly inter-related in a manner controlled by the DMS. Some of the ways in which features may be inter-related are:

- o Predecessor and successor relationship arising from a feature manipulation compilation function.
- o Geographic relationship of features which are located in proximity to one another.
- o Feature group relationship in which features belong to a common branch of the feature classification hierarchy.

The design concepts achieved by use and existence of both types of feature files are as follows:

- o Feature files can be re-input to the ACT System
- o Indexing performed prior to those functions requiring such
- o Phase I functions will operate on either feature file
- o Feature files are in standard ACT System format

The most critical aspect of the system design is data retrieval. The key to achieving the optimum performance of the DMS will be to minimize the total accesses required to store, modify or retrieve feature data. The DMS must permit a variety of access techniques to avoid sequential search, including the following:

- o Retrieve feature by ID number
- o Retrieve feature by locational index grid cell within a threshold and belongs to a certain feature group
- o Retrieve all features belonging to a feature group
- o Retrieve all features belonging to a feature group that also occupy a certain area.

b. <u>General Content</u>

The data base will consist of a variety of file types. These will include but not be limited to the following:

- o Feature File
- o Indexed Feature File
- o Product Specification Files
- o Symbol and Character Libraries
- o Compilation Summary File

Each of these files will contain a file header describing the contents of the file. The information contained in these headers will vary with file type. This descriptive data is required to provide an overview of the file contents. A general list of the information contained in the file header is presented below. This is not a complete list. It provides a conceptual representation of the file header contents.

- o File name
- o File type
  - feature file
  - product specification file
- o Date created
- o Date modified (last)
- o Relevant cartographic facts
  - sheet name, locality designation
  - sheet number
  - highest feature number
  - production specification (JOG,ONC, TPC)
  - latitude, longitude lower left corner

- latitude, longitude control points
- number of control points
- font types
- scale
- file history indicators
- highest feature number in file
- projection type

A primary element of the data base is the Feature File and the cartographic feature which consists of a lineal cartographic representation and a feature description. Each feature belongs to one and only one feature class, which is the entry-level of the cartograhic group relationship. The classification of each feature will be self-contained within its feature description. The hierarchical feature classification structure will be the same as or a simple derivation of a structure common to many current cartographic data bases. The hierarchical group structure consists of:

o Feature Class

o Feature Type

o Feature Subtype

o Feature Descriptors

Additionally, a degree of textual and auxiliary descriptive data is required to fully describe the feature. The descriptive data contents are obtained through investigation of the production specifications and user requirements. This descriptive data will reside in the feature header and include:

o Feature ID

o Number of Header Records

- o Number of Feature Segment Records
- o Special Numeric
- o Name
- o Comments (free text)
- o First and Last (X,Y) coordinate
- o Minimum and Maximum (X,Y) coordinate
- o Intersection Points
- o Intersecting Feature ID
- o Hold Points
- o Compilation Facts
  - Function(s) performed on feature (e.g., scaled, feature extraction, etc.)
  - Actions taken against feature (e.g., accept/reject, segment shift, etc.)
  - Date performed
  - Exception flag
  - Text font
- o DMS data

A set of the descriptive data should be retained in a segment header. The existence of a master header and segment header is suggested here. This concept provides the ability to describe a feature segment differently than the feature, in turn providing a method of subjective feature processing. It further allows the functions to perform their tasks more effectively by providing them with more detailed information.

The content of the Product Specification Files are fully discussed in the following section. The Symbol and Character Libraries will contain the digital image of the more complex symbols used to represent features on the finished product, alphanumerics and other special characters.

These libraries will be maintained at the smallest point size used and scaled to generate larger point sizes. They will be created at a large scale to provide greater accuracy. A separate Character Library is required for each style.

c. Structure and Processing Concept

The structure of this data base is important to operation of the automtic batch compilation processes in the ACT system. Prior to developing the design of the data base, the following processing concepts must be considered.

(1) Compatibility with Interactive Structure

To facilitate the development of a complete compilation system, the structure of the data base should be compatible (possibly identical) to that of an interactive compilation system. This concept will allow for the continued refinement of the data base in an efficient and timely manner. The cartographer could utilize this method of repeated batch and interactive processing to achieve a cartograpically accurate product.

(2) Segment Feature History

A complete history of the functions performed on each feature and of feature segments modified will be useful to the development of a complete compilation system. A history field in the feature master header is required to indicate the last action performed on the feature. Additionally a history field is required in each modified feature segment header to indicate actions taken on the segment. These fields are used to record a feature's trail of events. As a modification is made on a feature segment, the action must be recorded. The cartographer can then use this information to assist in the proofing and further correction (if required) of the features. The corrections could be made in the interactive or batch mode. This information may also prove useful in the batch compilation area. Functions otherwise not feasible may become so by exploiting the data in the history field.

A partial list of the cartographic facts required in the history field is:

- o Functions performed
- o Extent of adjustments, where applicable
- o Acceptance/rejection codes
- o Cartographer action
- o Date of action

An example of the use of a history field in the feature file is given in Figure II-5. This figure depicts the use of a history field in the feature master header and each feature segment header. Further, it shows that upon each modification to the feature, the feature master header is updated and each segment header is augmented to contain history information.

(3) <u>Expandable Header</u>

The feature header is the vehicle used to maintain the feature identification; the feature segments depict the cartographic portrayal of the feature. In previous cartographic data bases, the feature segments have been variable in length, whereas the header has been a fixed length. This header type can only store a finite set of information. By allowing a fixed master header with variable length segment headers linked together in a manner similar to feature segment data, the amount of information stored becomes expandable. A preliminary storage structure is presented to develop a conceptual design approach for the DMS (Figure II-6).

d. <u>Support</u>

The data base requires support software to efficiently store, update, and retrieve data. This software must emphasize optimization of speed and space. Files will reside on disk. This rapid access mass storage device provides for storing and accessing large quantities of cartographic data in a timely manner.

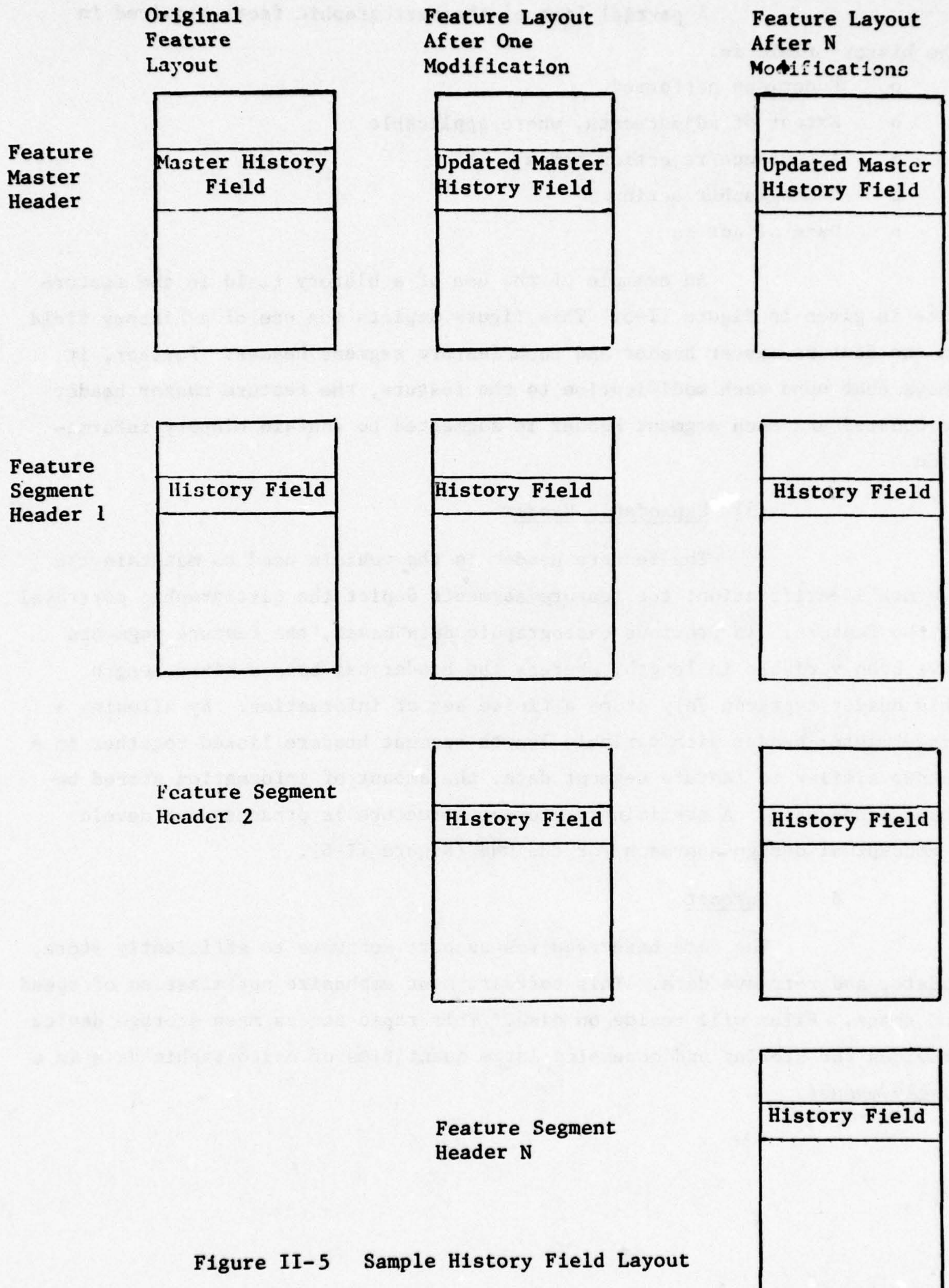

Figure II-5 Sample History Field Layout

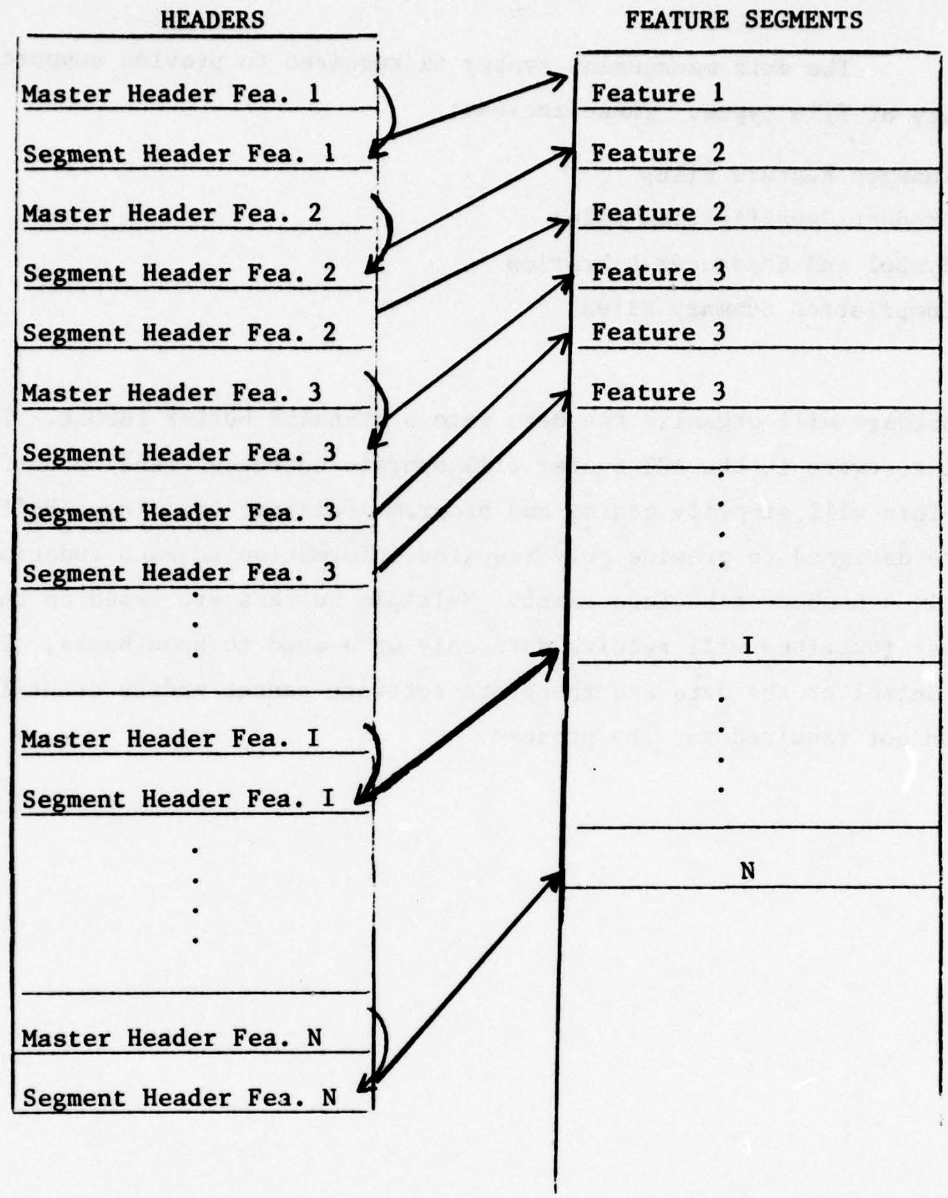

Figure II-6 Preliminary Storage Structure

The data management system is required to provide support to a variety of file types. These include:

- o Indexed Feature Files
- o Product Specification Files
- o Symbol and Character Libraries
- o Compilation Summary Files

The DMS software will organize the data into a standard buffer format. The functional software in the ACT System will operate on these standard buffer formats. This will simplify coding and program modification. These buffer formats are designed to provide only required information to each function. Consequently a number of buffers exist. Multiple buffers are based on the concept that functions will receive data only on a need to know basis. This provides control of the data and therefore software cannot modify or utilize information not required for its process.

7. Product Specification File

a. Role and Services

The Product Specification File (PSF) provides direction and guidance for the Advanced Compilation Techniques (ACT) system processes. In the manual compilation process, production specifications and professional expertise dictate the appropriate actions for a given chart. The PSF assumes a portion of this role in the batch compilation process. To effectively perform this role, subjective areas of the production specifications must be reflected in the PSF. This requires transformation of guidelines from their current human oriented form into precise numerical terms allowing software interpretation. This ideally should be accomplished by a group of cartographers to obtain objectivity by consensus. Thus, the graphics produced by the automated system would exemplify those compiled manually. Due to the subjective nature of the specifications, the same chart compiled by n different cartographers can produce n different results. Conversely, due to the objective nature of the PSF, the same chart compiled repeatedly on the automated system will always produce the same results.

The PSF directs much of the feature processing within a function. Criteria indicating the functions to be performed on a feature are also provided. Thus, software decisions are based on PSF parameters. These combined with external control determine the flow of data through the system components. The controlling nature of the PSF dictates that it contain accurate, readily accessible information.

b. Contents

Various types of information are maintained within the PSF. This includes:

- o tolerances
- o symbol and text placement directions
- o feature selection criteria
- o conflict identification parameters
- o conflict resolution parameters
- o desired feature characteristics (e.g., closed)

- o feature priorities
- o parameters unique to automated systems

This information represents both the required function parameters and the production specifications. A partial list of the function parameters is included in Appendix A.

Production specifications differ for each product type. Analysis of the Joint Operations Graphic (JOG) and Operational Navigation Charts (ONC) production specifications indicates the necessity of a separate PSF for each product type. Thorough analysis of the specifications is required to determine the exact contents of each PSF. The PSF contents will dictate the criteria which must be met prior to performing each ACT process. Appendix A illustrates some of the guidelines to be included in the PSF. The examples given support, in part, several ACT functions:

- o Feature Extraction
- o Automatic Feature Culling
- o Coalescence Deletion
- o Coalescence Shift

c. Structure Concept

The PSF is an extremely crucial component of the ACT system. It is an interpretation of the production specifications which are subject to modification as technology advances or as DMA missions change. The design of the PSF must therefore incorporate the qualties of a good structured design. The storage scheme shall be readily expandable while not consuming excessive space. During ACT system processing, the PSF is envisioned as residing on a rapid access mass storage device with permanent storage on magnetic tape.

Access into and software interpretation of the PSF will be facilitated by its structure. This structure is based upon the ACT software requirements and the PSF contents. The PSF configuration consists of parameters arranged within feature classifications arranged by function (See Figure II- 7). This is suited to all phases of the ACT system.

Function

Feature Classification

Parameter

Parameter

Feature Classification

Parameter

⋮

Parameter

⋮

Feature Classification

Parameter

Function

Feature Classification

Parameter

Parameter

Feature Classification

⋮

Figure II-7 PSF Structure Configuration

The PSF contents dictate, to some extent, the exact structuring of specific parameters within each feature classification.

d. Support

Software is required to create, maintain and access the PSF. PSF guidelines are crucial to the ACT system and proper PSF structuring should provide rapid retrieval of the desired information by the appropriate Data Management System (DMS) service.

Creation and maintenance of the PSF are low priority, background operations. They may be considered a separate subsystem and include:

- creation of the PSF
- transfer of the PSF between magnetic tape and mass storage
- addition of guidelines to the PSF
- deletion of guidelines from the PSF
- replacement of guidelines within the PSF (deletion, then addition)
- deletion of entire (portions of) PSF
- printing of the PSF

C. Software Structure and Processes

1. Structural Overview

The Advanced Compilation Techniques System (ACTS) defined in this document is a modular system designed according to the philosophies of structured top down design. A full set of compilation and supportive functions were defined by the initial system requirements. Certain crucial functions which demonstrate batch compilation techniques have been selected for the preliminary development. These functional elements are illustrated by Figure II-8.

Three distinct, functionally cohesive processing phases have been identified:

- Data Formatting, Commonization and Reduction
- Conflict Identification and Adjustment
- Compilation Finishing

A System Controller regulates control and data flow between these phases. It also regulates communications with the system user. Each phase consists of a group of compilation and/or supportive functions. These functions are governed by a Phase Controller. Support Services perform separately identifiable tasks which may be required by several functions. The Data Management System (DMS) Services are the vehicle for interaction with the various data files. Phase I processes features on an individual basis. All interaction with DMS Services in Phase I is via the controller. Phases II and III must be aware of feature relationships. Various support and DMS Services are required by each function, and thus are requested by the functions.

The ACT System has been decomposed so as to identify the purpose of all required functional processes and Support and DMS Services. The following section defines the requirements of each functional software level identified by this decomposition process. The standard terminology used throughout is defined in Appendix B. Figure II-8 defines the symbology used in the data flow graphs.

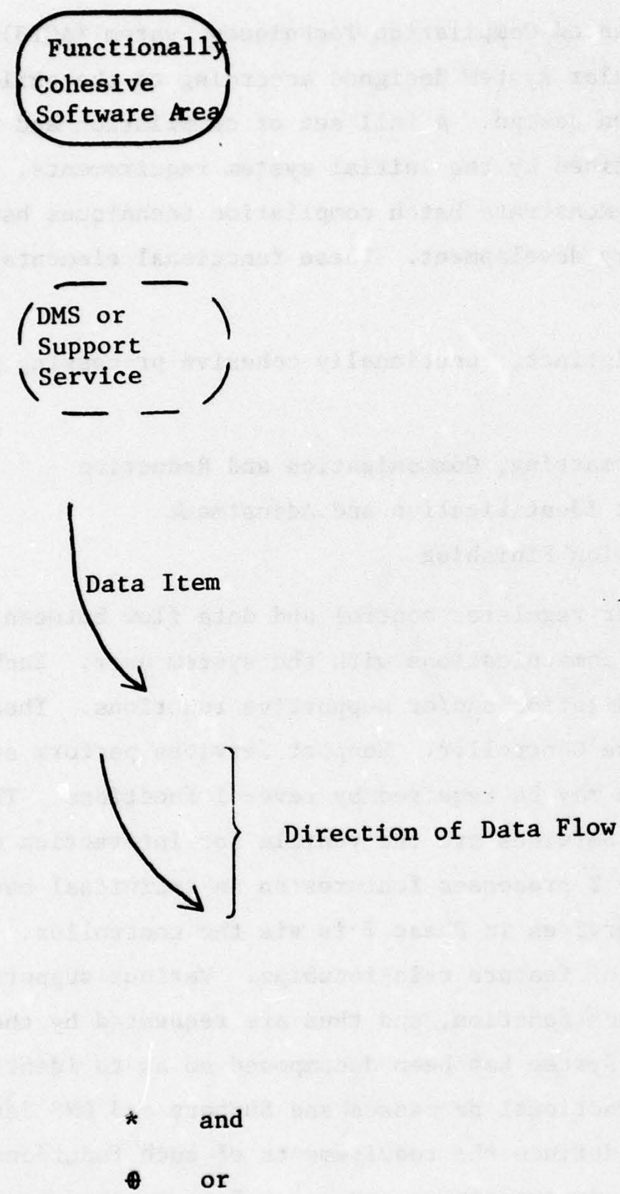

Figure II- 8 Data Flow Graph Legend

2. System Controller

The System Controller regulates the Advanced Compilation Techniques (ACT) System. This software is responsible for coordination between user input, system software components, data base components, and system reporting. In addition, it must initiate subordinate ACT Phase software in the proper sequence.

The System Controller is initiated by and responds to the operating system. In a batch environment, this is governed by the run stream control cards. Communications between the System Controller and the software components can be construed as the "input" to the System Controller. This "input" data is interpreted and utilized in governing the ACT System processing.

The System Controller begins by requesting the User Control Service. This may require some type of input device identification (e.g., card reader or terminal logical unit identifier) as input. This service responds by defining a series of Parameter Buffers (PBs). Each contains processing parameters for a specific (portion of a) Phase of the ACT System. These PBs are retained, in sequence, by the System Controller. The User Control Service signals the System Controller when the final PB is completed and other processing may be initiated.

These PBs are utilized by the System Controller to initiate the proper functions in the proper sequence. They also provide the vehicle by which information is transferred from the user to the appropriate software. The System Controller insures that software can access this information only on a need to know basis via regulation of these PBs. Actual processing within the System Controller is relatively simple. It begins with the first PB and continues through the sequence to the last. The Phase indicator within the PB is examined and the appropriate Phase Controller initiated. The current PB and any continuation PBs are input to the Phase Controller. The System Controller is notified upon Phase completion, and the next PB examined. This cycle continues through all PBs. The Process Reporting Service is requested after all phases have completed. It may or may not

have an associated PB. Upon report completion, the System Controller is notified and a response (i.e., exit) is issued to the operating system.

The System Controller is notified in the event of an irrecoverable error. Appropriate actions (e.g., close file) are taken. Error information is stored in the Compilation Summary File via the DMS service. The Process Reporting Service is requested. Upon completion of the report, the job aborts.

3. Phase I

a. Phase I Controller

The Phase I Controller regulates the less complex Data Formatting, Commonization, and Reduction processes. This includes:

- acceptance and verification of user input parameters
- preparation of input to each function
- initiation of appropriate functions in the proper sequence
- verification of output from each function
- interfacing with the necessary DMS service routines
- updating the Compilation Summary File
- response to the System Controller

The Phase I Controller receives user parameters from the System Controller via the Parameter Buffer. These parameters include the functions to be performed, any non-standard function sequencing, and all required and user override parameters for the functions. In addition, the Phase I Controller must be notified if any Phase II or Phase III functions have been requested.

The Phase I Controller interprets and validates the user parameters. These, along with standard procedures, serve as guidelines for construction of the process flow control stream. This control stream indicates the functions to be performed and their sequence. Phase I functions are illustrated by Figure II-9. They include:

- Input External
- Feature Extraction
- Scale
- Line Smoothing
- Output External

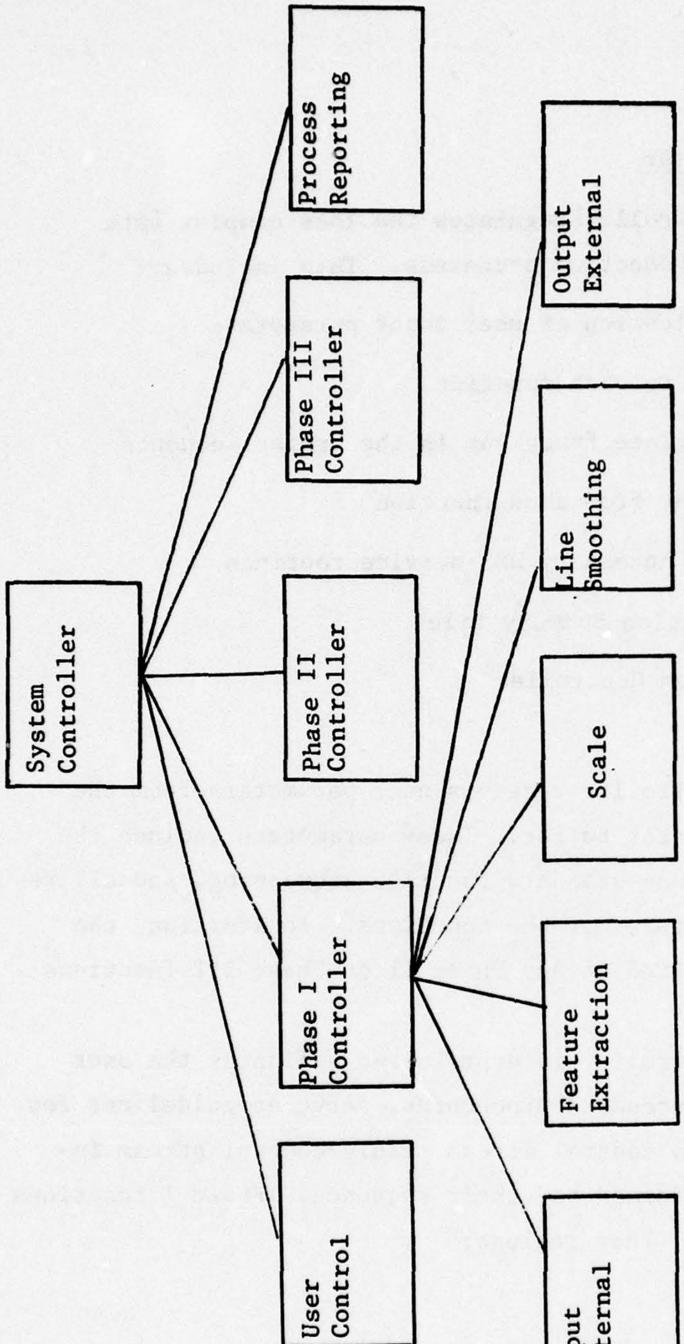

Figure II- 9 Phase I Functional Breakdown

Feature relationships have no affect upon Phase I processes. Features are processed individually. Indexing is not required. In Phase I, each feature is processed by all appropriate functions before proceeding to the next feature. Therefore, the Phase I Controller initiates and regulates the process flow of each feature through the functions. The cycle is repeated until all features have been processed. Control is then returned to the System Controller.

For each function, the Phase I Controller prepares the input, initiates the function, and validates the response. It also serves as a repository for information which must be retained by one function while another function is active. Phase I Controller processing is similar, but not identical,for all functions. In general, input to each function consists of a Feature Buffer containing a feature header and data record, a Product Specification Buffer (PSB), and appropriate indicators (i.e., end of feature). The Product Specification Buffer is constructed by the Phase I Controller. It contains the PSF guidelines updated by user overrides and additional user parameters for each function. The amount of information required for each function will determine if an individual PSB is required for each function or if one (or two) PSB will suffice.

The response to the Phase I Controller will consist of the Feature Buffer, an updated Compilation Summary Buffer, and any appropriate indicators. Exceptions include:

- o Input External does not require a Feature Buffer as input
- o Extraction does not require feature data records as input
- o Output External does not return a Feature Buffer as output

The process flow control stream is modified when the Extraction Function identifies a feature to be deleted. In this case, the remainder of the functions need not be performed on that feature. The Extraction Function may also identify a feature as not requiring any Phase II or III processing. Such features are immediately processed according to the control stream defined for post Phases II and III processing. Additionally, each function recognizes error conditions and notifies the Phase I Controller. These errors are then returned to the System Controller.

The origin and destination of features processed by the Phase I functions is indicated by the process flow control stream. Selection of the Input External or Output External Functions indicates that features originate from magnetic tape, or are output to magnetic tape, respectively. Absence of these functions indicates Phase I interaction with the ACT Feature File residing on disk. The Output External Function is not immediately performed when any Phase II or III functions are requested. In this case, features are stored in the ACT Indexed Feature File via the DMS services. These features are indexed by the DMS as they are stored. Similarly, when the Input External Function is not selected, features are obtained sequentially from the ACT (Indexed) Feature File via the DMS service. The Phase I Controller accomplishes required interaction with DMS services.

Upon completion of Phase I processing, the Phase I Controller returns control to the System Controller. The Compilation Summary Buffer has been continually revised by the functions. The DMS services are used to perform the update of the Compilation Summary File. In the event of an irrecoverable system error, the Phase I Controller provides the System Controller all information necessary for an orderly system shutdown.

The Phase I functions are addressed below. Input, process, output requirements and performance objectives are discussed for each function. In adhering to the philosophies of structured design, individual function processes are transparent to all external ACT system components. That is, within each function, all other functions and the controllers are defined only by their purpose. Similarly, a function can access data only on a need to know basis.

b. Input External

(1) Purpose

The Input External Function obtains lineal cartographic data from magnetic tape and converts it to ACT standard system format.

(2) Description

(a) Input

A feature data magnetic tape, tape identifier, file name, and source data format are input to this function. An indicator requesting a new feature or continuation of a feature is also supplied.

(b) Processes

The Input External Function reads a feature record (header or data) from magnetic tape. If a new feature is requested, any continuation records on the tape are ignored and the next feature header is read from the tape. This record is converted to the ACT standard system format and placed in a Feature Buffer. The Phase I Controller initiates the process for each record and receives the Feature Buffer. Initial tape read, end of file, and/or end of tape indicators will be recognized, and the Phase I Controller notified. Appropriate information is placed in the Compilation Summary Buffer. Any tape errors are recognized and processed accordingly. Figure II-10 illustrates the data flow for this function.

(c) Output

The Input External Function returns its output to the Phase I Controller. This includes a properly formatted feature record in the Feature Buffer, process information in the Compilation Summary Buffer, and any appropriate error response. The output may include indicators for:

- Beginning of File
- End of File
- End of Feature
- Feature Header Record
- Feature Data Record

(d) Performance Objectives and Processing Variables

Design of the Input External Function must be modular, facilitating incorporation of various input formats. Initial development software will accept ACT standard system format and one external format input data. The system user is required to supply source tape and format identification. Time and space requirements of this function should be minimal. Optimization of time resources is restricted only by the time necessary to read the magnetic tape.

Within a feature, input records may differ in length from a Feature Buffer. The Input External Function will recognize and process this condition appropriately.

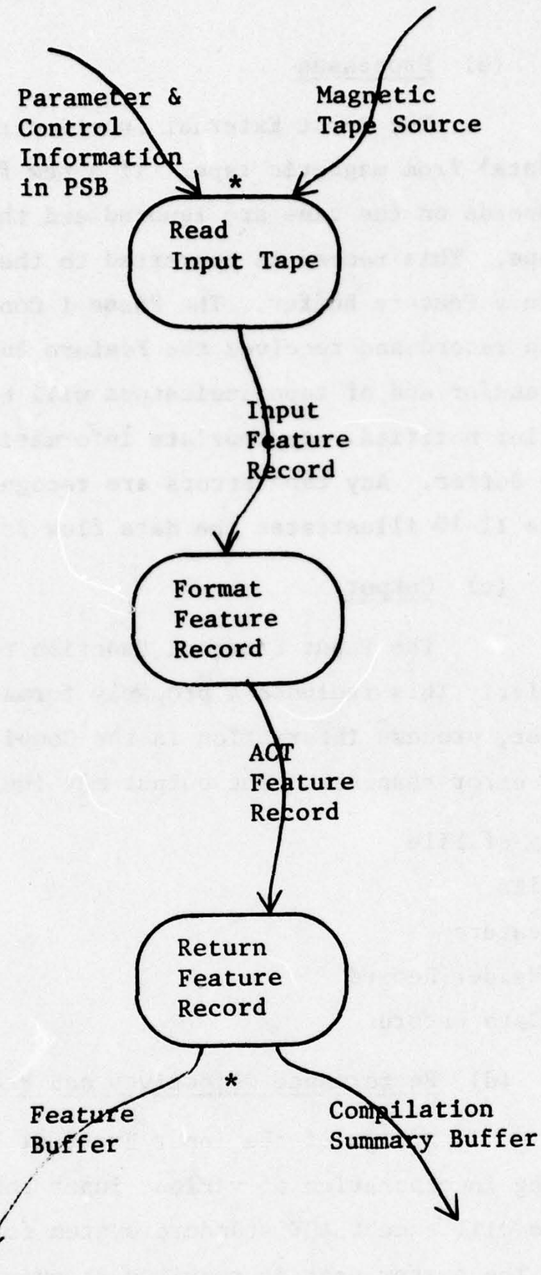

Figure II- 10 Input External Data Flow Graph

c. Feature Extraction

(1) Purpose

This function will provide a basic service of selecting features for further compilation processing, suppressing features from Phase II and III processing, and rejecting features from any further compilation processing. This capability provides a flexible tool to automatically flag features for selection or rejection and additionally the ability to select a single unique feature or feature group for further specific processing.

(2) Description

(a) Input

Input will consist of a Feature Buffer containing a feature header and a Product Specification Buffer (PSB). This PSB contains user input and PSF data pertinent to Extraction. User input will consist of:

- Indicator to use PSF or user parameters or both
- PSF overrides
- Individual feature ID's to be selected/rejected

(b) Processes

The Feature Extraction Function will flag each feature for selection, suppression from Phase II and III processing, or rejection for the production compilation. This will involve comparison of the feature classification (e.g., unique ID, class, type, subtype, descriptors, special numerics) with the Extraction criteria in the PSB. The Feature Buffer and appropriate flag are returned to the Phase I Controller. The Compilation Summary Buffer is updated with the required information. Error conditions are recognized and processed accordingly. Figure II- 11 illustrates the data flow of the Feature Extraction Function.

(c) Output

The primary output from Extraction is a status flag being set to select/suppress/reject the feature. Any processing statistics pertinent to the function are recorded in the Compilation Summary Buffer.

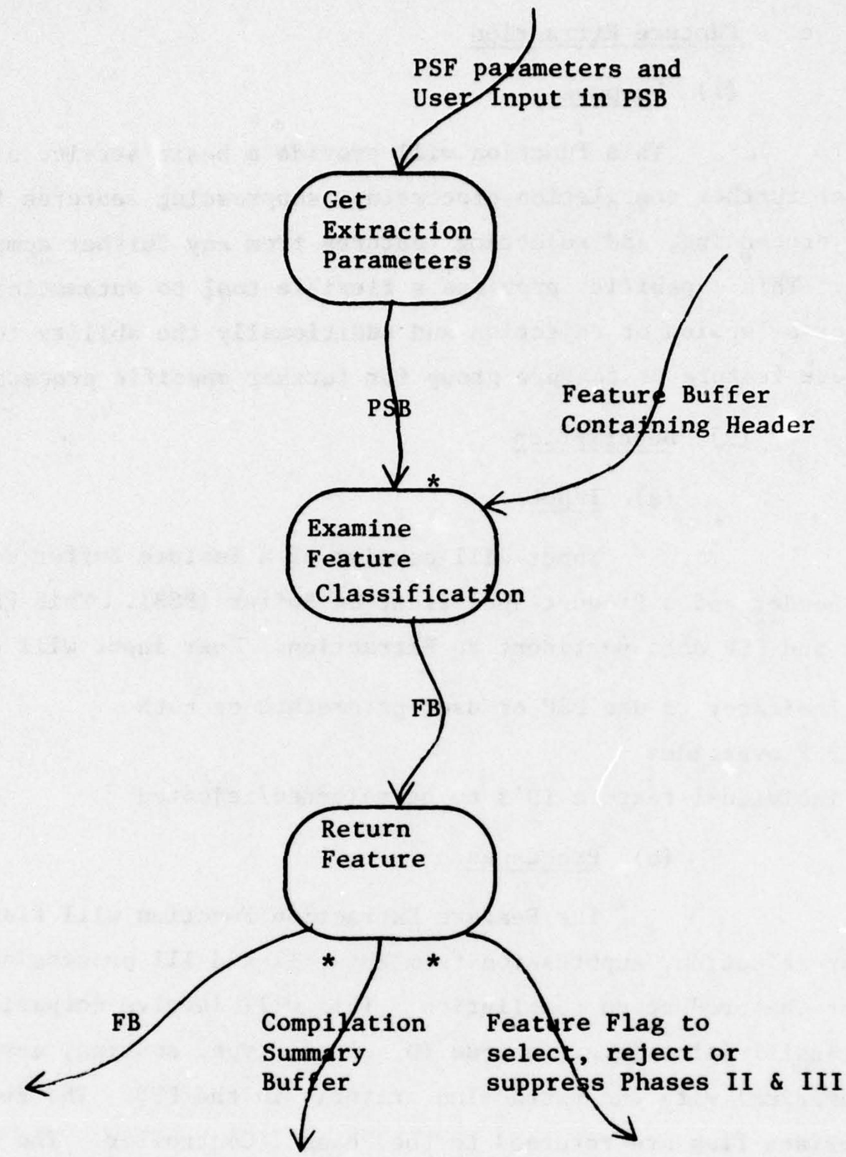

Figure II- 11 Feature Extraction Data Flow Graph

(d) Performance Objectives & Processing Variables

The Extraction Function must allow for extensive flexibility for defining feature extraction parameters. The design must allow the user to extract a single feature as well as a complete feature group for further compilation processing, deletion, or suppression from Phase II and III types of processes.

d. Scale

(1) Purpose

The Scale Function mathematically converts the scale of a cartographic feature, such that relative geometric relationships are maintained.

(2) Description

(a) Input

A Feature Buffer containing a feature header or data record is input to the Scale Function. Additional required input includes feature or data record identifiers, start and end of feature indicators, and new scale or previously computed scaling factor.

(b) Processes

The scaling factor must be determined from the original and new scales prior to actual scaling of the ACT Feature File. The new scale is obtained from the Parameter Specification Buffer (PSB). The original scale must be available from the Feature File control records or from user input in the PSB. The Scale Function updates the file control with the new scale. Scaling requires the modification of each feature data point and the corresponding update of all appropriate header information (e.g., min, max, x,y coordinates). The header records are updated after the feature points in all data records have been scaled. The required header update information is determined by the Scale Function during the data record processing. The Phase I Controller insures that this function receives the feature records in the proper sequence and that the start and end of feature indicators are set correctly. Appropriate information is recorded in the Compilation Summary Buffer. Any errors encountered are processed accordingly. Figure II-12 depicts the data flow of the Scale Function.

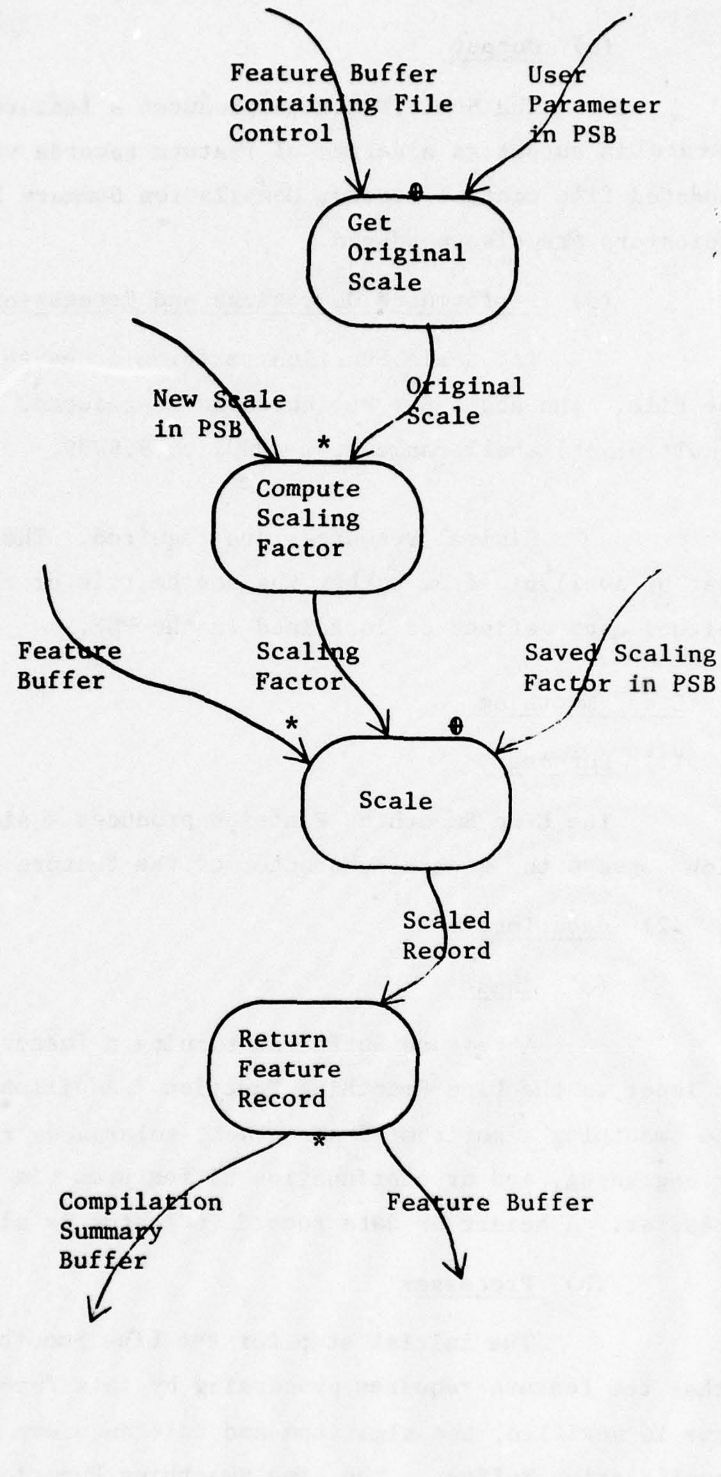

Figure II-12 Scale Data flow Graph

(c) Output

The Scale Function produces a feature at the new scale. This feature is output as a series of feature records via Feature Buffers. An updated file control record, Compilation Summary Buffer, and appropriate indicators are also produced.

(d) Performance Objectives and Processing Variables

The Scale Function performs a change in scale of the ACT Feature File. The scale may be increased or reduced. The scaling factor (i.e., multiplier) shall range from .0001 to 9.9999

Minimal resources are required. The original chart scale must be available from either the source file or the user; the new scale is either user defined or contained in the PSF.

e. Line Smoothing

(1) Purpose

The Line Smoothing Function produces a simplified, less dense line which conveys the general character of the feature.

(2) Description

(a) Input

A Feature Buffer containing a feature header or data record is input to the Line Smoothing Function. Additional input includes the line smoothing algorithm(s) per class, tolerances required, and indicators for beginning, end or continuation of features via the Product Specification Buffer. A header or data record indicator is also supplied.

(b) Processes

The initial step for the Line Smoothing Function is to verify that the feature requires processing by this function. Once the feature type is verified, the algorithm and tolerance are obtained from the Product Specification Buffer. The Line Smoothing Function

performs the required processes on the data record. These include resolution maintenance and/or line smoothing with different algorithms as specified in the Product Specification Buffer. Upon completion, an updated data record will be returned to the Phase I Controller via the Feature Buffer. This function will also return error indicators to the Phase I Controller. The Compilation Summary Buffer is updated with the appropriate statistical data. Figure II-13 depicts the data flow of the Line Smoothing Function.

(c) Output

The output from this function is an updated data record buffer, Compilation Summary Buffer, and any error or processing indicators required by the Phase I Controller.

(d) Performance Objectives and Processing Variables

The Line Smoothing Function is required to reduce the resolution and smooth a feature while retaining the original characteristic of the feature. It must be capable of processing each feature type with the algorithms specified at the requested tolerance. The tolerance will be related to the feature class algorithm specified and product type. The tolerance field should be sufficiently large enough to hold the tolerance value regardless of algorithm it is associated with. The Line Smoothing Function will perform resolution maintenance in conjunction with or separately from the other line smoothing algorithms. This will allow performing a line smoothing algorithm without resolution maintenance. The user must be provided with the capability to override any specification.

f. Output External

(1) Purpose

The Output External Function converts the ACT Feature File to the requested format and transfers that file to magnetic tape for permanent storage or plotting.

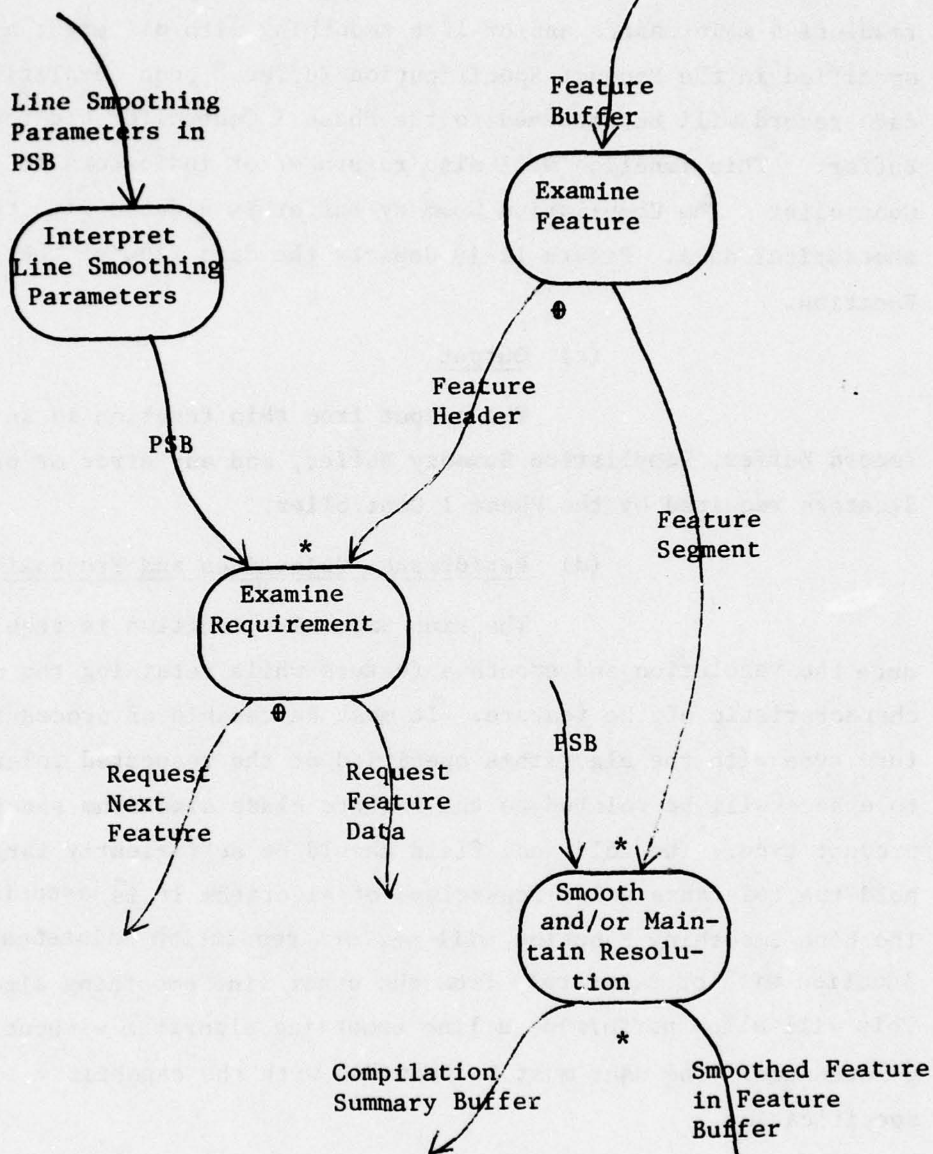

Figure II- 13 Line Smoothing Data Flow Graph

(2) Description

(a) Input

A Feature Buffer containing a feature header data record is input to this function. Additional input includes desired output format, magnetic tape identification, and indicators for start or end of file, start or end of feature and header or data record. This is provided via the Product Specification Buffer.

(b) Processes

A Feature Buffer is received from the Phase I Controller. The feature information is converted to the output format and records are written on tape. Special processes insure proper generation of the tape label, end of file, and end of tape records. Required information is placed in the Compilation Summary Buffer. Any tape errors are recognized and processed. Figure II-14 depicts the data flow of the Output External Function.

(c) Output

A properly formatted lineal cartographic feature file on magnetic tape is produced by the Output External Function. Additional output includes indicators for end of feature and end of file and report information in the Compilation Summary Buffer.

(d) Performance Objectives and Processing Variables

The function design will be modular to facilitate the addition of output file formats. Initial development software will provide the capability to transfer an ACT Feature File and at least one external format file to magnetic tape. A plot tape will be one type of external format produced. The system user must identify the tape and the output format. Within a feature, output records may differ in length from a Feature Buffer. The Output External Function will recognize and process this condition. Required resources will be optimized; this is restricted only by the time required to perform the tape write operation.

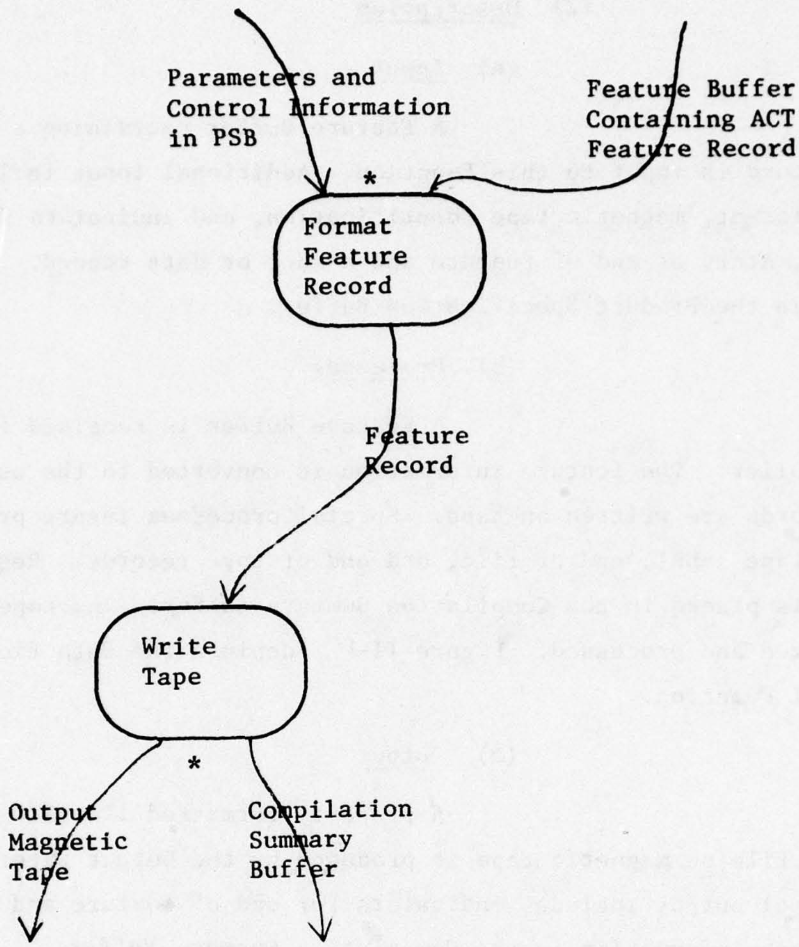

Figure II-14 Output External Data Flow Graph

It may be desirable to save the ACT Indexed Feature File on tape. The actual feature data is the same as for an ACT Feature File and thus is acceptable to the Output External Function as defined in this document. Maintenance of the locational and descriptive indices on magnetic tape may require special processes. These processes are dependent upon both the hardware devices utilized and the exact file and index formats. As such, investigation into the feasibility of retaining the Indexed Feature File on tape should be performed during detailed system design.

4. Phase II

a. Phase II Controller

The software developed here will control the Conflict Identification and Adjustment functions. It will:

- o receive control and parameters from the System Controller
- o interpret parameters received
- o request function
- o provides function required parameters
- o receive control and parameters from function
- o interpret parameters received
- o call another function or return control and parameters to System Controller

This software is less sophisticated than Phase I control software. Its decision processes are limited. The parameters supplied by the user and Product Specification File determine the required functions and their sequence. This information is received by the Phase II Controller via the Parameter Buffers. Therefore this software need only direct its functions and serve as an interface between them.

The Phase II Controller will provide the System Controller with all necessary information for an orderly system shutdown when an unresolvable system error has occurred. The information will be passed as parameters and will include:

- o file name of files open
- o functions completed
- o functions to be performed
- o function being performed
- o error code
- o feature ID error occurred on

The Phase II functions are depicted in Figure II-15. They include:

- o Automatic Feature Culling
- o Coalescence Deletion
- o Coalescence Shift
- o Symbol Change

The input, processes, and output requirements for each function are presented below. These functions will be responsible for requesting the DMS Service to store and retrieve data for the data base. The required access technique is dictated by the function, therefore the function is best suited for controlling access of the data.

b. Automatic Feature Culling

(1) Purpose

The purpose of the Feature Culling Function is to automatically select or reject features based on product specifications and feature relationships. The function must consider: feature selection/ rejection criteria contained in the PSF; regional physical and cultural geographic factors which impact feature selection; relationships of features which impact area portrayal; and density factors which might guide the depth of features retained. This function is similar to Feature Extraction although intended to provide a more rigorous determination of feature selection/rejection.

(2) Description

(a) Input

The primary inputs will be compilation specifications and guidelines provided from the PSF and/or user and the Indexed Feature File containing the feature headers and data points. Specifically the types of information will include the following:

- o Feature Priorities
- o Regional Characteristics
  - Wet/Arid
  - Level of Transportation Network
  - Population Pattern

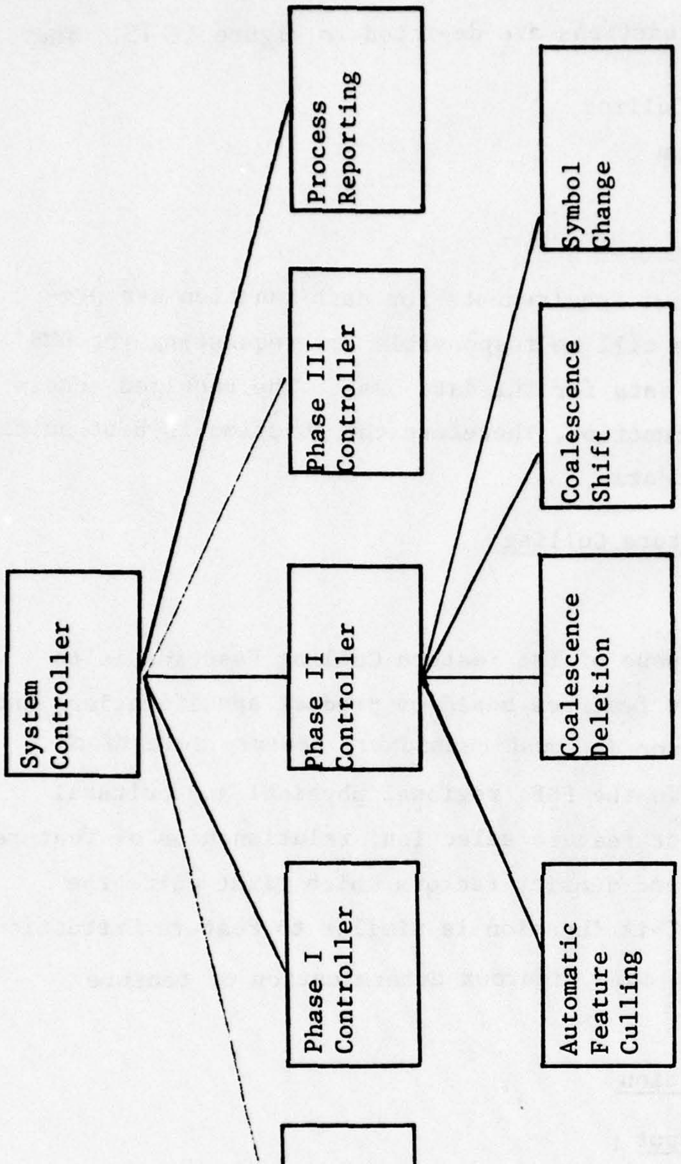

Figure II- 15 Phase II Functional Breakdown

- Type of Terrain
- Level of Cultural Development

o Feature Group Selection/Rejection Specifications
- Feature Group (e.g., unique ID, class, type, subtype)
- Feature Descriptors
- Feature Size (e.g., length, area)

o Feature Dependencies

(b) <u>Processes</u>

The Feature Culling Function will systematically compare all features residing in the Indexed Feature File against product specification information. The result will be that each feature header will be flagged as:

o Accepted

o Unresolved

o Rejected

The major processing steps (see Figure II-16) will include:

Step 1. Access appropriate sections of PSF and identify "next" feature group to process, based on priorities.

Step 2. Get "next" feature of designated feature group via DMS services.

Step 3. Compare feature against feature group specifications (i.e., class, type, subtype, descriptors) to determine unconditional acceptance or rejection.

Step 4. If conditional case, investigate specific conditions (i.e., size, feature density, relationship with other features, regional characteristics).

Step 5. Flag feature according to determination in 3 or 4 and restore via DMS Service.

Step 6. Return to Step 2 until all features of that group have been processed.

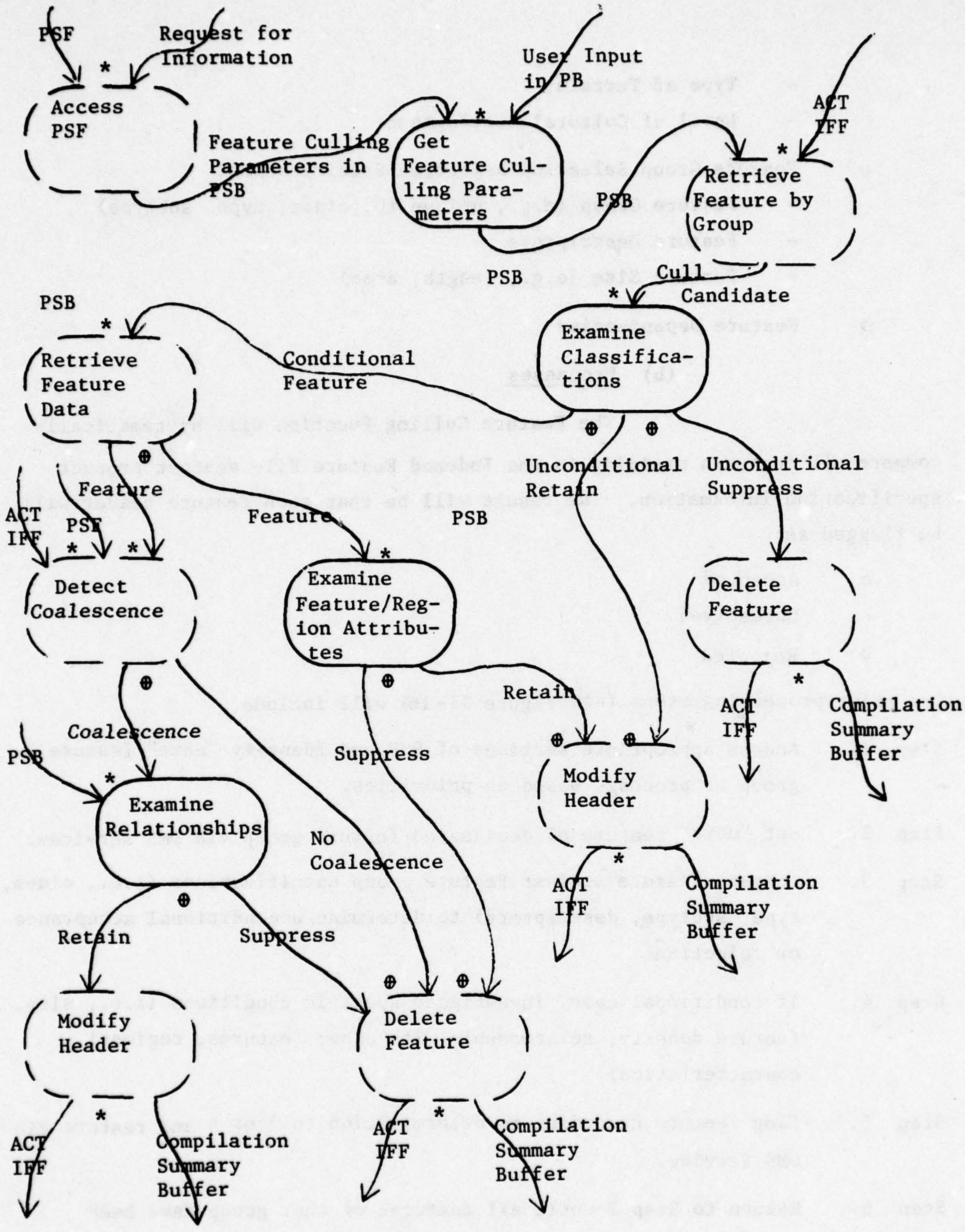

Figure II-16 Automatic Feature Culling Data Flow Graph

Step 7. Return to Step 1 until all feature groups have been processed.

Consideration should be given to assigning numeric codes to each feature based on the degree and/or rationale for accepting or rejecting each feature. For example, those features which are specified as absolutely required on the product (Step 3 above) would be assigned a "90" while those rejected would be assigned a "10". Other reasons for selection would be assigned a code between 20-80 as illustrated in Figure II-17. A major use of this technique will be to maintain a record of the basis for the determination and to provide the user with a vehicle to vary the depth of feature selection.

(c) Output

The primary outputs will consist of accept/reject codes associated with appropriate feature headers. Additionally, statistics will be collected and maintained in a Compilation Summary Buffer for actions taken (e.g., number of deletes/accepts) and feature densities associated with each accept/reject level.

CODE	REJECTION/ACCEPTANCE
10	REJECTED (based on feature header)
20	REJECTED (based on feature size)
30	REJECTED (based on regional factors)
40	REJECTED (based on overall feature density)
50	UNRESOLVED
60	ACCEPTED (based on overall feature density)
70	ACCEPTED (based on feature size or regional characteristics)
80	ACCEPTED (based on relationship with other features)
90	ACCEPTED (based on feature header)

Figure II-17 Levels of Feature Selection/Rejection

c. Coalescence Deletion

(1) Purpose

The Coalescence Deletion Function detects and resolves through deletion illegal coalescences for the file. This provides an improved portrayal and interpretability of the selected feature information.

(2) Definition

(a) Input

The ACT Indexed Feature File (IFF) provides cartographic feature information to this function. Additional input in the form of processing parameters and guidelines is provided by the Product Specification File (PSF). This is augmented and optionally overridden by the user. Input includes, but is not limited to:

- o product type (user)
- o file name or identifier (user)
- o feature classifications which coalesce illegally and may be resolved via feature (segment) deletion
- o minimum length of coalescence segment to be resolved via deletion
- o minimum separation between non-coalescing features (i.e., coalescence tolerance)
- o feature classifications whose internal area (i.e., area features) is considered for coalescence

(b) Processes

The Coalescence Deletion Function must gather input from the user and the PSF. Data Management System (DMS) services are utilized to obtain the required PSF information. This data is placed in a

Product Specification Buffer (PSB). It is updated according to user-specified override parameters in the Parameter Buffer (PB). Thus, later processes are able to obtain all necessary parameters from the PSB.

This function obtains candidate coalescences via the Coalescence Detection Service. Candidate coalescences are illegal coalescences which may be resolved via deletion. These are identified by feature classification as defined in the PSB. A primary feature is obtained via the DMS service to retrieve feature by group. Primary feature classifications are the major PSB organization. Candidate classifications are listed for each primary in the PSB. The Coalescence Detection Service is requested to locate all coalescences between the primary and candidate features. The primary feature master header is provided via a Feature Buffer.

Each candidate coalescence located by the Coalescence Detection Service must be examined by this function to insure that the segment exceeds the minimum length prior to deletion. The feature segment is then deleted from the IFF via the DMS service. Segments less than minimum length are retained. Each primary feature is resubmitted to the Coalescence Detection Service until each coalescence has been located and resolved and a "no coalescence" response is received. The next primary feature is then retrieved and processed similarly. This continues until all features for each primary classification have been processed and control returns to the Phase II Controller. Appropriate statistics are posted into the Compilation Summary Buffer. Any error conditions cause control to return to the Phase II Controller. Figure II-18 illustrates the data flow of this function.

(c) Output

Conflicts within the ACT Indexed Feature File are resolved by this function. Additional output from the Coalescence Deletion Function includes the updated Compilation Summary Buffer and error indicators as required.

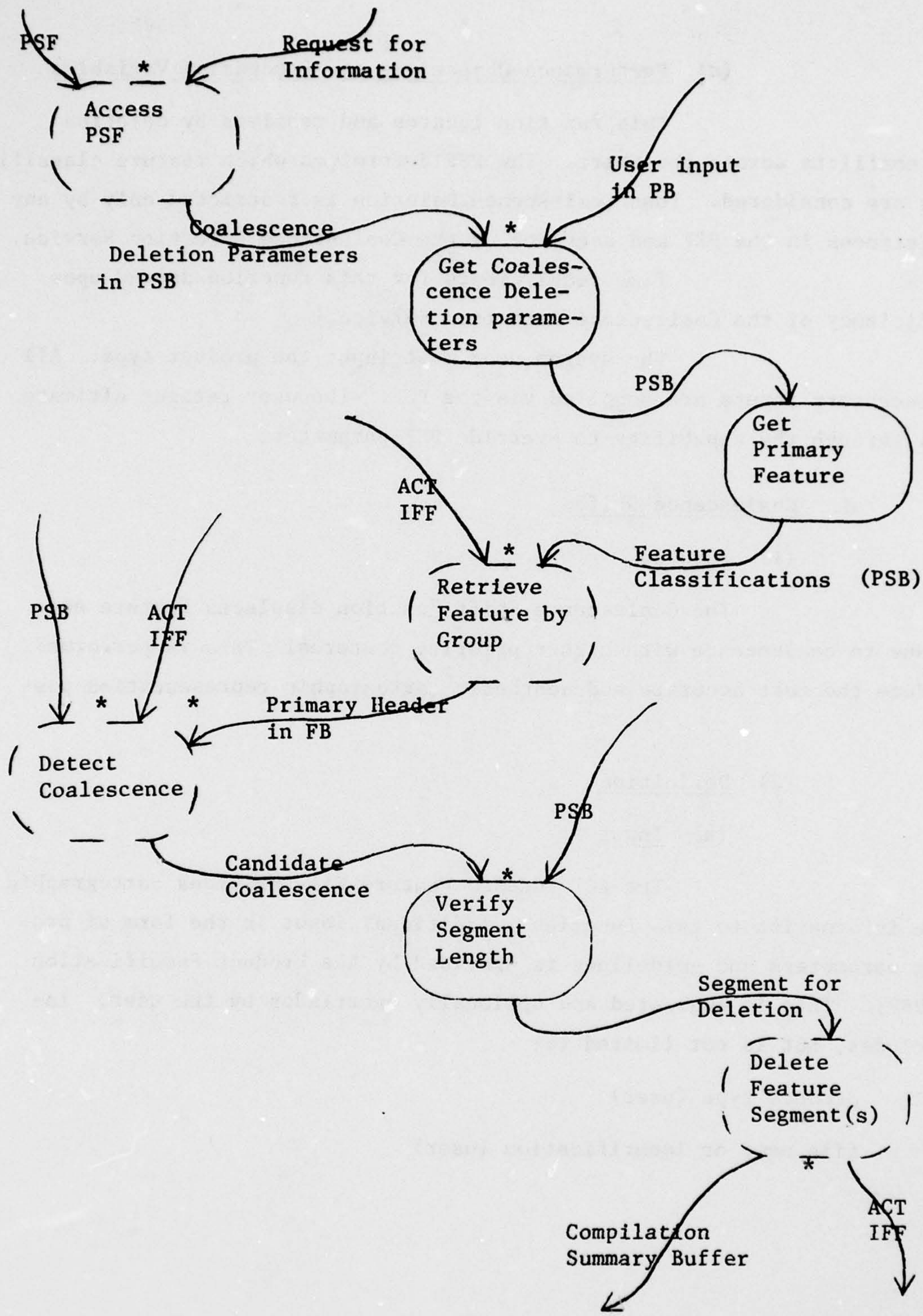

Figure II-18 Coalescence Deletion Data Flow Graph

(d) Performance Objectives and Processing Variables

This function locates and resolves by deletion feature conflicts across the chart. The PSF determines which feature classifications are considered. Thus, Coalescence Deletion is restricted only by any incompleteness in the PSF and accuracy of the Coalescence Detection Service.

Time requirements for this function depend upon the efficiency of the Coalescence Detection Service.

The system user must input the product type. All other necessary inputs are supplied via the PSF. The user retains ultimate control through the capability to override PSF parameters.

d. Coalescence Shift

(1) Purpose

The Coalescence Shift Function displaces feature segments due to coalescence with higher priority features. This is performed to produce the most accurate and aesthetic cartographic representation possible.

(2) Definition

(a) Input

The ACT Indexed Feature File provides cartographic feature information to this function. Additional input in the form of processing parameters and guidelines is provided by the Product Specification File (PSF). This is augmented and optionally overridden by the user. Input includes, but is not limited to:

- o product type (user)
- o file name or identification (user)

- o feature classifications which coalesce illegally and may be resolved via feature (segment) shift
- o minimum length of coalescence segment to be resolved via shift
- o minimum separation between non-coalescing features (i.e., coalescence tolerance)
- o feature classifications whose internal area (i.e., area features) is considered for coalescence
- o priority criteria used to determine which of the coalescing features should be modified
- o direction of shift, where applicable
- o maximum distance a feature segment may be shifted

(b) Processes

The Coalescence Shift Function must gather input from the user and the PSF. Data Management System (DMS) services are utilized to obtain the required PSF information. This data is placed in a Product Specification Buffer (PSB). It is updated according to user-specified override parameters in the Parameter Buffer (PB). Thus, later processes are able to obtain all necessary parameters from the PSB.

This function obtains candidate coalescences via the Coalescence Detection Service. Candidate coalescences are illegal coalescences which may be resolved via shift. These are identified by feature classification as defined in the PSF. A primary feature is obtained via the DMS service to retrieve feature by group. Primary feature classifications are the major PSB organization. Candidate classifications are listed for each primary in the PSB. The Coalescence Detection Service is requested to locate all coalescences between the primary and candidate features. The primary feature master header is provided via a Feature Buffer.

Each candidate coalescence located by the Coalescence Detection Service must be examined by this function to insure that the segment exceeds the minimum length prior to modification. Segments less than minimum length are not modified. This function is identical to the Coalescence Deletion Function to this point.

The appropriate feature segment is then shifted to resolve the conflict. This shift must not generate additional conflicts. Absence of conflict is verified by requesting the Coalescence Detection Service to locate any illegal coalescence with the new feature segment. The DMS service is requested to replace the original with the new segment if no further conflicts are identified. Otherwise, the original segment is updated via the DMS to indicate that it is an unresolvable conflict. Each primary feature is resubmitted to the Coalescence Detection Service until each coalescence has been located and resolved and a no coalescence response is received. The next primary feature is then retrieved and processed similarly. This continues until all features for each primary classification have been processed and control returns to the Phase II Controller. Appropriate statistics are posted into the Compilation Summary Buffer. Error conditions cause control to return to the Phase II Controller. Figure II-19 illustrates the data flow of this function.

(c) Output

Conflicts within the ACT Indexed Feature File are resolved or annotated by this function. Additional output from the Coalescence Shift Function includes the updated Compilation Summary Buffer and error indicators as required.

(d) Performance Objectives and Processing Variables

This function locates and shifts conflicting feature segments across the chart. Shifting requires generation of a new feature segment which is offset from, maintains the character of and joins smoothly with the original feature segment. The PSF determines which feature classifications are considered. Coalescence Shift is restricted only by any incompleteness in the PSF and accuracy of the Coalescence Detection Service.

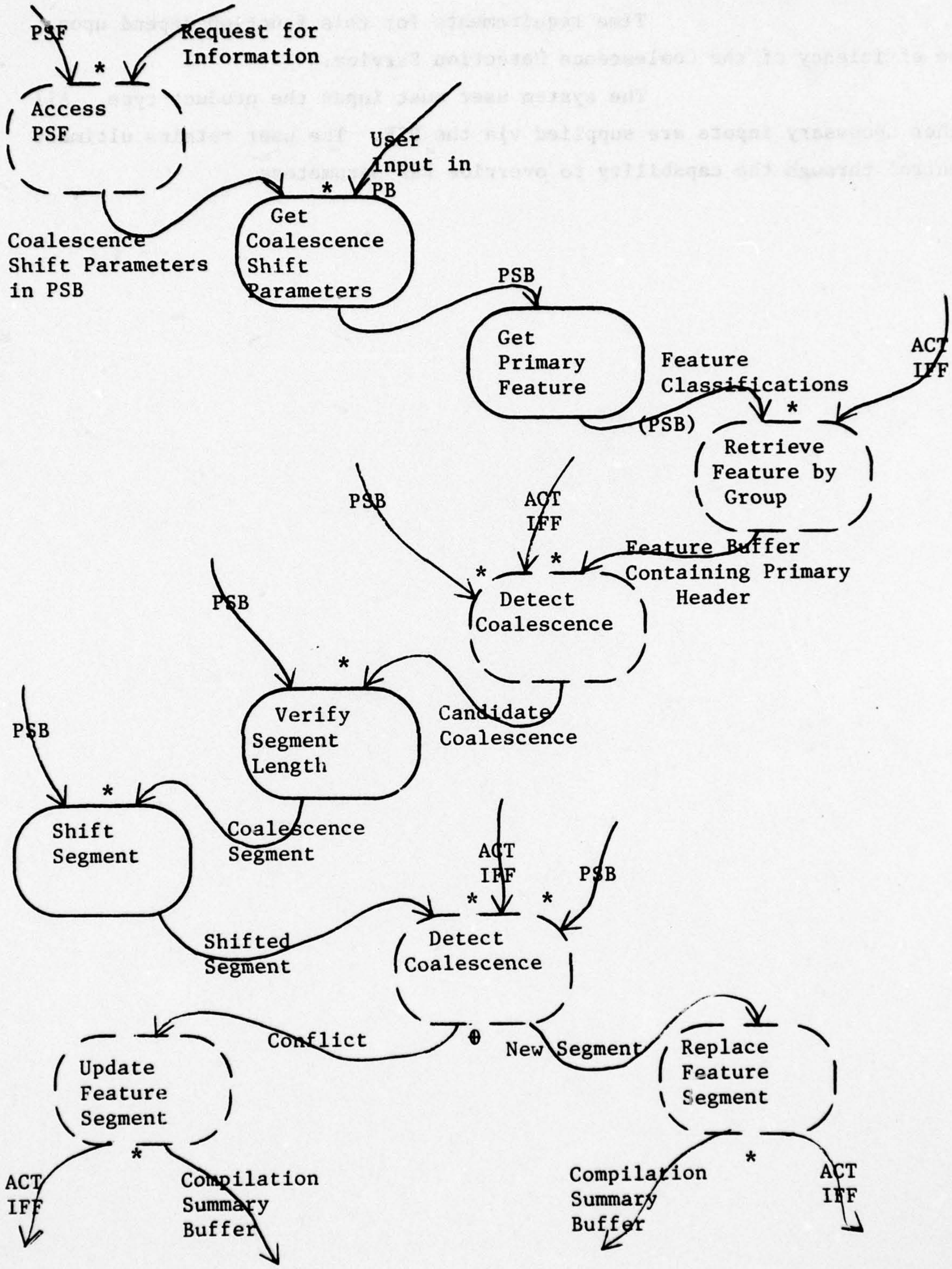

Figure II-19 Coalescence Shift Data Flow Graph

Time requirements for this function depend upon the efficiency of the Coalescence Detection Service.

The system user must input the product type. All other necessary inputs are supplied via the PSF. The user retains ultimate control through the capability to override PSF parameters.

e. Symbol Change

(1) Purpose

The Symbol Change Function simplifies feature portrayal. It is required after a scale reduction. The capability to convert double to single line streams and area features to point symbols are initially provided. Certain feature relationships will be retained during this process.

(2) Description

(a) Input

The ACT Indexed Feature File (IFF) provides cartographic feature infoımation to this function. Processing parameters and guidelines are provided by the Product Specification File (PSF) and from the user via a Parameter Buffer (PB). This input includes:

- o area feature classifications which may become point symbols
- o for each area feature classification, the parameters which must be met (exceeded) for the feature to be represented by a point symbol (i.e., city area on actual map)
- o the desired symbology for each area feature classification
- o feature classifications which are considered closed
- o for each feature classification symbolized, the related feature classifications which may require modification
- o for each related feature classification requiring modification, the criteria to be met, the type of change to be made (i.e., extend roads to city symbol; delete all city streets) and associated parameters

(b) Processes

The Symbol Change Function gathers input from the PSF and the user. Required PSF information is retrieved and placed in a Product Specification Buffer (PSB) via DMS services. This is augmented and updated by user parameters from the PB. Subsequent processes obtain all required information from the PSB.

Double line streams are maintained as two features within the ACT Indexed Feature File (IFF). Each feature represents one side of the stream and has a side indicator (i.e., left, right). Within each, the feature identifier for the other side is maintained, if known. The Symbol Change Function obtains one side via the DMS service to retrieve feature by group. The associated feature must then be obtained. This is accomplished via the DMS service to retrieve feature by ID when the identifier is known. Otherwise, the Coalescence Detection Service is requested to locate all coalescences of double line streams and the previously retrieved side (i.e., primary feature). The feature which coalesces at the minimum distance is accepted as the opposite side. The minimum separation between opposite sides of a double line stream is used as the coalescence tolerance. Thus, a response of no coalescence indicates that this double line stream requires no symbol change. Similarly, a coalescence segment represents those feature segments which must be converted to a single line stream. When the corresponding stream side can be retrieved by ID function, the Coalescence Detection Service is requested with both features to determine if symbol change is required.

Conversion to single line requires generation of a new feature segment midway between the original segments. This segment must join smoothly with the remainder of the features. A coalescence segment less than the minimum length remains unchanged. The Coalescence Detection Service is again requested to locate all conflicts with this new segment (e.g., islands). Any conflicts located are properly resolved (e.g., islands are deleted).

The Symbol Change Function converts area features to point symbols. The area feature classifications are obtained from the PSB. Candidates are extracted via the DMS service to retrieve feature by group. Each candidate is examined to determine if it meets the symbol change criteria (e.g., city area) defined in the PSB. Only those meeting all criteria are replaced with a point symbol. This symbol is defined in the PSB according to feature classification and is positioned at the centroid point of the original feature. All related features must be adjusted to correspond with the new feature. A clip/join process is performed on features which intersect the original. Those features interior to the original are deleted (e.g., city streets). Related feature classifications and the associated required actions are defined in the PSB. The Coalescence Detection Service is requested to locate all coalescences between the original and related features. The original feature (primary) header is provided via a Feature Buffer. Each coalescence response indicates a related feature which is then modified. After adjustment of all related features, the new feature is added to the IFF and the original is deleted.

These processes are repeated until all appropriate symbology has been modified and control returns to the Phase II Controller. Appropriate statistics are posted into the Compilation Summary Buffer. Error conditions are recognized and returned to the Phase II Controller. Figures II-20 and II-21 illustrate the data flow of this function.

(c) Output

Feature portrayal within the IFF is improved by this function. All streams are properly depicted by one or two lines; all appropriate area features are represented by point symbols. Additional output from the Symbol Change Function includes the updated Compilation Summary Buffer and error indicators as required.

(d) Performance Objectives and Processing Variables

This function improves feature portrayal within the ACT IFF. Although only the conversion of single to double line streams and area features to point symbols are included here, enhancements to the

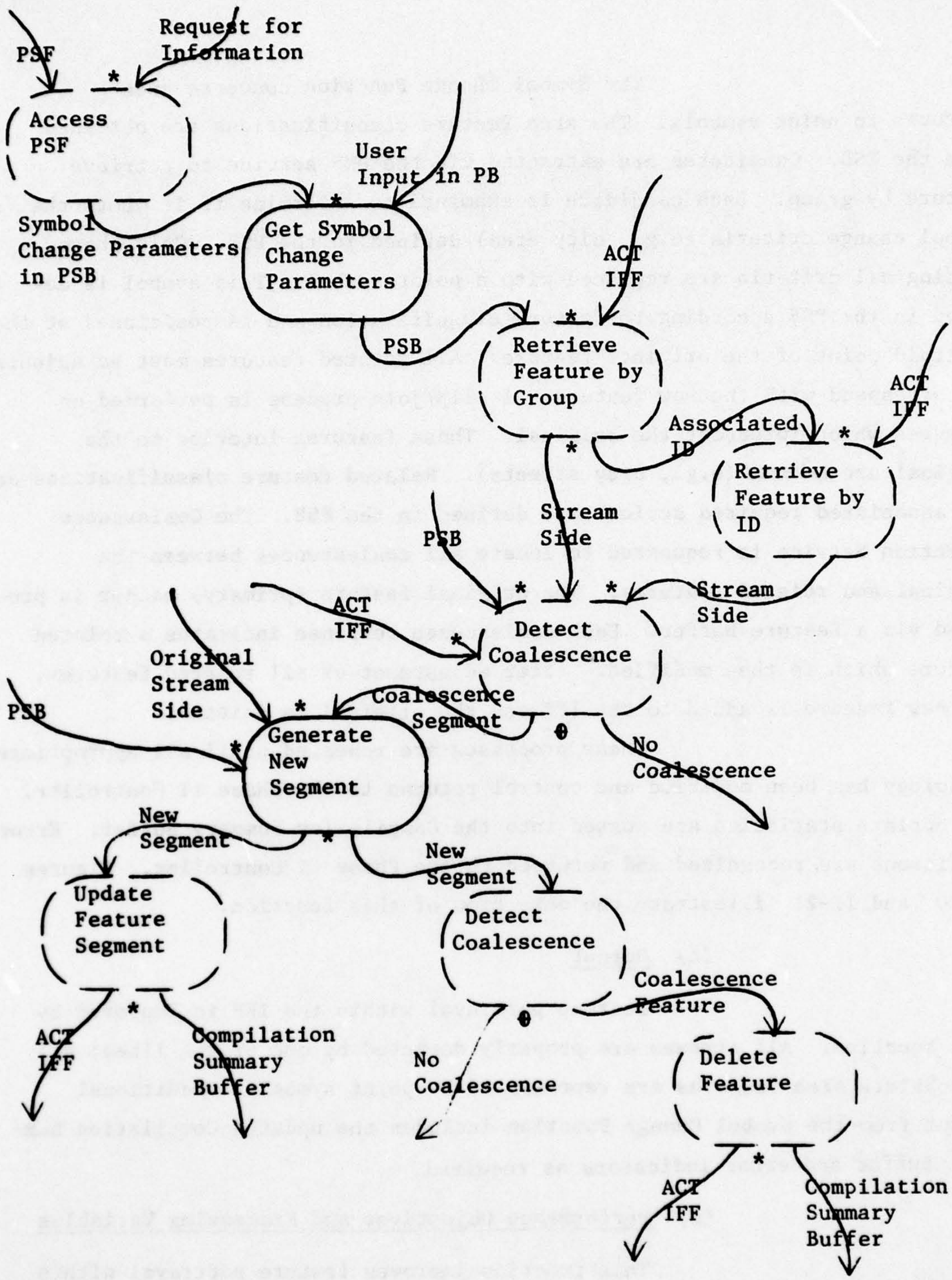

Figure II- 20 Symbol Change Data Flow Graph (streams)

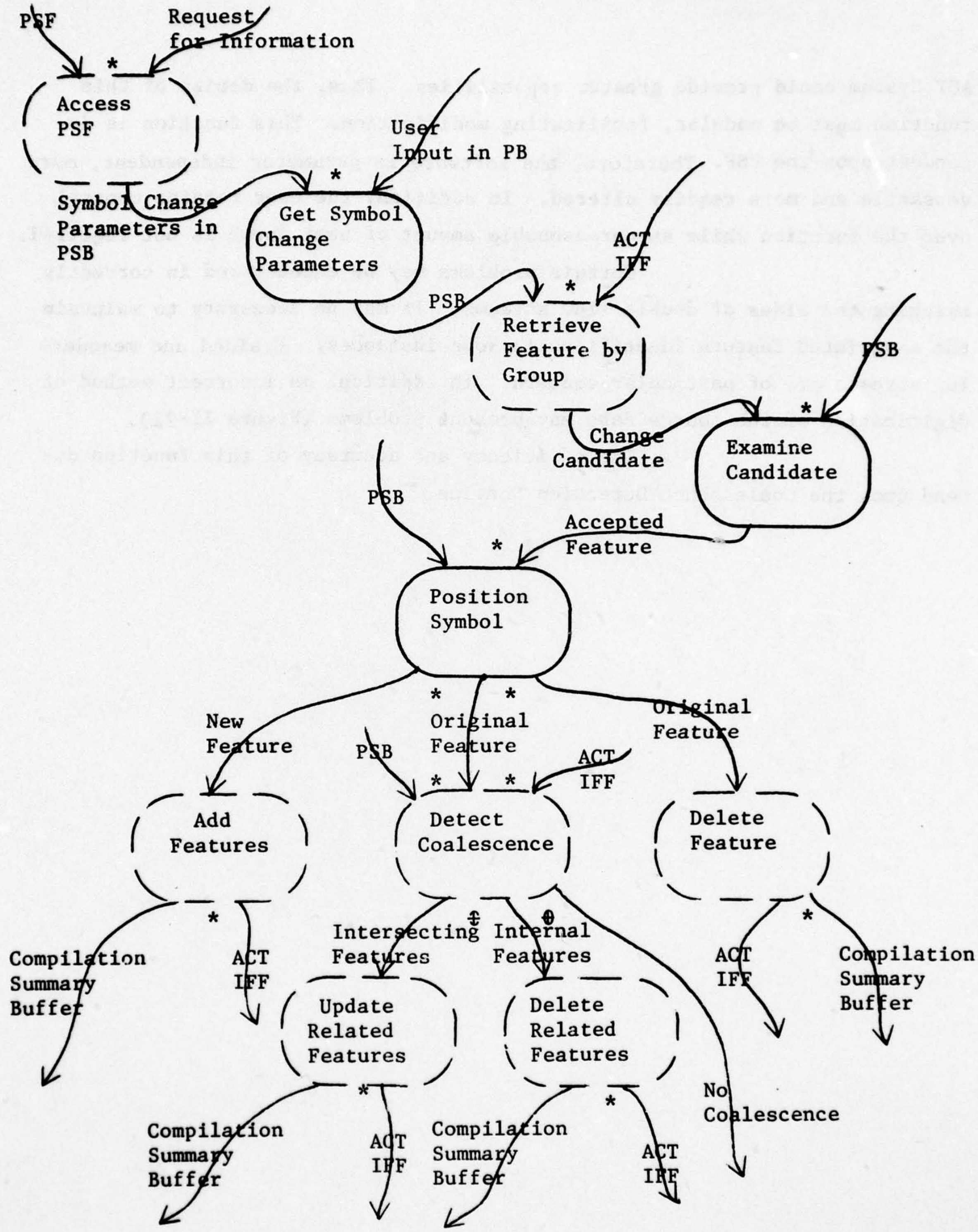

Figure II- 21 Symbol Change Data Flow Graph (area to point)

ACT System could provide greater capabilities. Thus, the design of this function must be modular, facilitating modification. This function is dependent upon the PSF. Therefore, the software is parameter independent, more versatile and more readily altered. In addition, the user retains control over the function while an unreasonable amount of user input is not required.

Certain problems may be encountered in correctly matching the sides of double line streams. It may be necessary to maintain the associated feature identifiers in some instances. Braided and meandering streams are of particular concern. In addition, an incorrect method of digitization of the source data may present problems (Figure II-22).

The efficiency and accuracy of this function depend upon the Coalescence Detection Service.

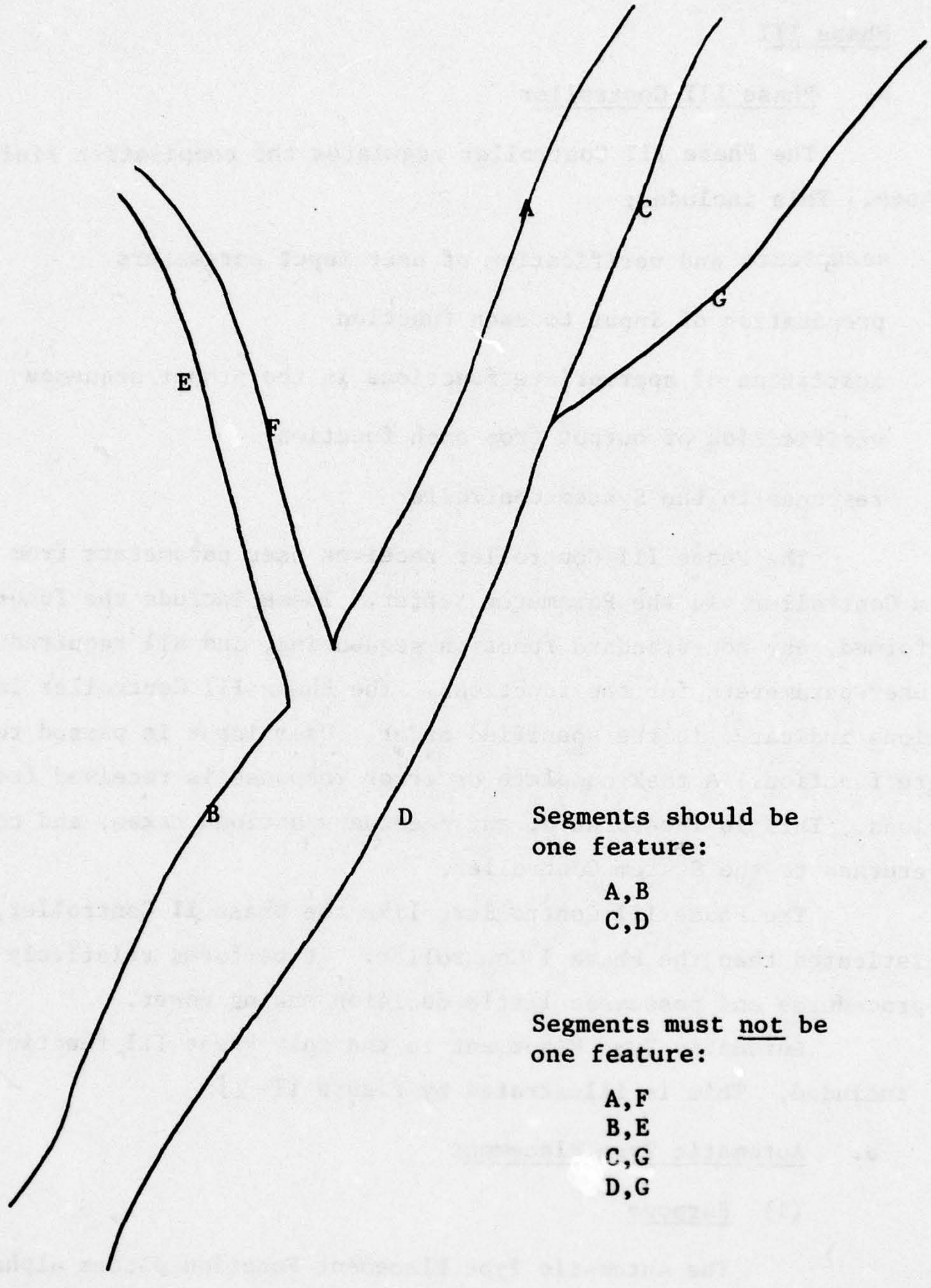

Figure II- 22 Stream Digitization

5. Phase III

a. Phase III Controller

The Phase III Controller regulates the compilation finishing processes. This includes:

- o acceptance and verification of user input parameters
- o preparation of input to each function
- o initiation of appropriate functions in the proper sequence
- o verification of output from each function
- o response to the System Controller

The Phase III Controller receives user parameters from the System Controller via the Parameter Buffer. These include the functions to be performed, any non-standard function sequencing, and all required and override user parameters for the functions. The Phase III Controller initiates the functions indicated in the specified order. User input is passed to the appropriate function. A task complete or error response is received from the functions. This is interpreted, any necessary actions taken, and control is returned to the System Controller.

The Phase III Controller, like the Phase II Controller, is less sophisticated than the Phase I Controller. It performs relatively standard procedures and possesses little decision making power.

Automatic Type Placement is the only Phase III function currently included. This is illustrated by Figure II- 23.

b. Automatic Type Placement

(1) Purpose

The Automatic Type Placement Function places alphanumeric characters relative to features on a chart. It provides the cartographer sufficient information for effective compilation proofing.

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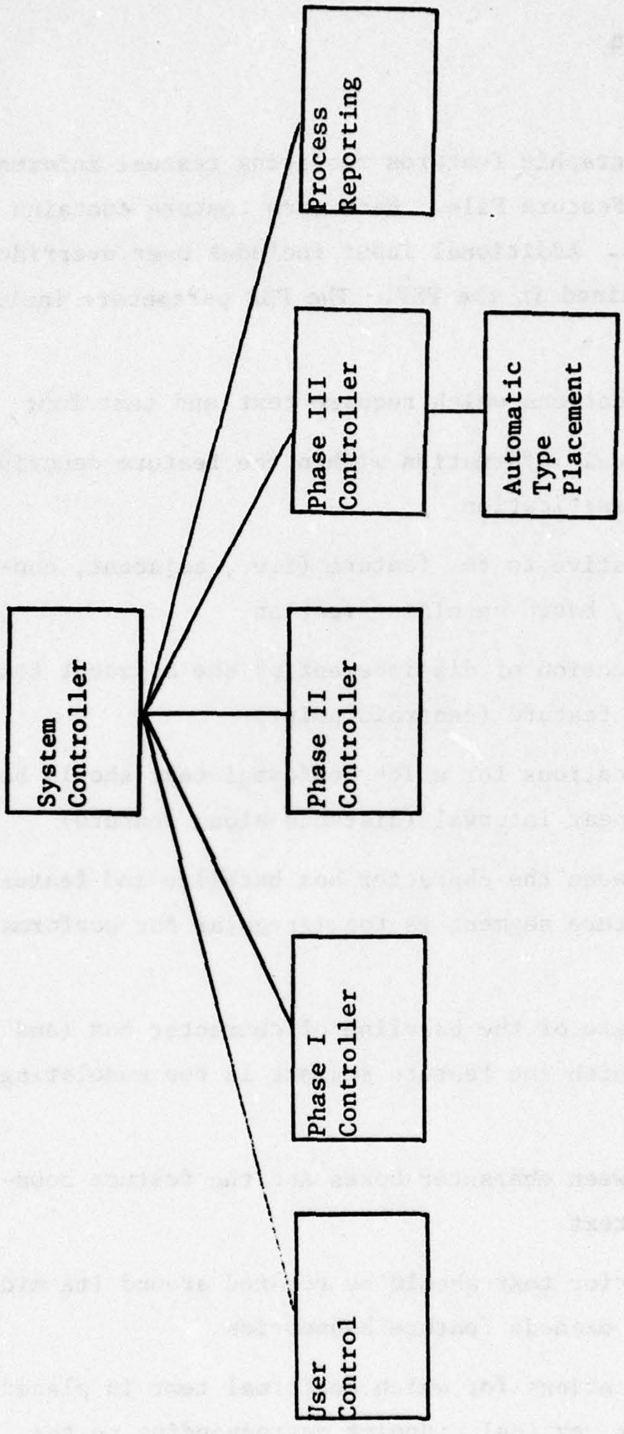

Figure II- 23 Phase III Functional Breakdown

(2) Description

(a) Input

Cartographic features requiring textual information are provided by the ACT Indexed Feature File. Each such feature contains indicators for the required text. Additional input includes user override parameters and information contained in the PSF. The PSF parameters include:

- the feature classifications which require text and text font
- the location of textual information within the feature descriptors, based on feature classification
- text orientation relative to the feature (i.e., adjacent, conformal, or interior), based on classification
- the distance and direction of displacement of the adjacent text start point from the feature (centroid point)
- the feature classifications for which conformal text should be repeated, and the repeat interval (distance along feature)
- maximum distance between the character box baseline and feature beyond which the feature segment is too irregular for conformal text
- maximum change in angle of the baseline of character box (and chart edge) beyond which the feature segment is too undulating for conformal text
- minimum distance between character boxes and the feature boundaries for internal text
- angles at which interior text should be rotated around its midpoint when that text exceeds feature boundaries
- the feature classifications for which conformal text is placed over the feature, its vertical midpoint corresponding to the feature's vertical midpoint and the feature segment deleted (i.e., contours)

o those feature classifications with which text may not coalesce (conflict)

(b) Processes

The Automatic Type Placement Function must gather input from the user and the PSF. Data Management System (DMS) services are utilized to obtain the PSF information. This data is placed in a Product Specification Buffer (PSB). It is updated according to user-specified override parameters in the Parameter Buffer (PB). Thus, later processes obtain all required parameters from the PSB.

Features requiring text are identified by classification in the PSB. This function obtains features via the DMS service to retrieve feature by group. Text positioning is then performed. The dimensions of each character are obtained from a table and a character box string is constructed. (When plotter generated characters are not used, each character must be retrieved from the Character Library via the DMS service and scaled as necessary.)

The text bounding rectangle can then be determined. The text is offset and rotated to the required position on the chart. This textual information may be placed adjacent to, conformal to, or interior to (within) a feature. Adjacent text is oriented along the horizontal; it's start point must be displaced from the feature. Conformal text must be placed along a smooth, non-undulating feature segment. Interior text must be contained completely within the feature.

The determined text position must not conflict with certain other features on the chart. The Coalescence Detection Service is requested to obtain any illegal coalescence with the text area. Feature classifications which conflict are provided via the PSB. When no conflict is located, the text and text placement is annotated in the IFF via the DMS service. (The text is appended as a feature when plotter characters are not used.) This annotation is accompanied by a conflict identifier, when applicable. Subsequent plot routines may or may not include conflicting text, depending upon the degree of accuracy required for compilation proofing. This process is repeated until all required features have text placement annotated. Control

then returns to the Phase III Controller. Process statistics are placed in the Compilation Summary Buffer. Error conditions are recognized and reported to the Phase III Controller. Figure II-24 illustrates the data flow of this function.

(c) Output

Text and text positioning is annotated into the Indexed Feature File by the Automatic Type Placement Function. Additional output includes the updated Compilation Summary Buffer and error indicators as required.

(d) Performance Objectives and Processing Variables

This function places text on the chart as an aid to compilation proofing. As such, the degree of accuracy required is less exacting than for the chart finishing processes. This accuracy may be controlled by the tolerances and conflicting feature classifications contained in the PSF. The time requirements of this function depend upon the efficiency of the Coalescence Detection Service and the required degree of accuracy. Actual text generation is currently planned to be accomplished by plotter hardware. A more sophisticated batch compilation system may generate several type fonts from a Character Library. This allows greater accuracy in proofing and approaches the [illegible] finishing process.

The user must identify the product type. All other necessary input is supplied via the PSF. The user retains ultimate control through the capability to override PSF parameters.

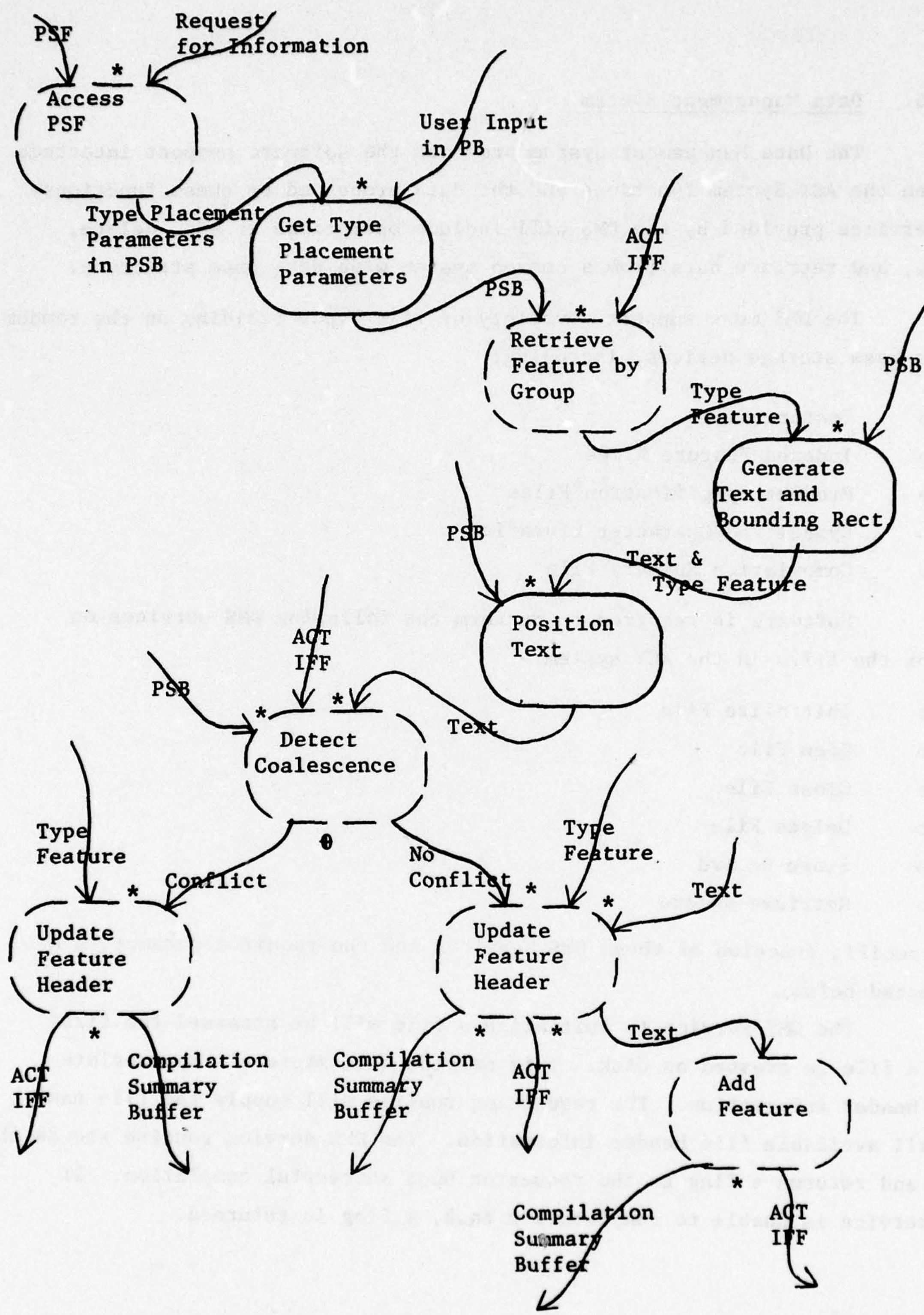

Figure II- 24 Automatic Type Placement Data Flow Graph

6. Data Management System

The Data Management System provides the software support interface between the ACT System functions and the data processed by these functions. The services provided by the DMS will include operations to add, delete, modify, and retrieve data from a common system-wide data base structure.

The DMS must support a variety of file types residing on the random access mass storage devices, including:

- o Feature Files
- o Indexed Feature Files
- o Product Specification Files
- o Symbol and Character Libraries
- o Compilation Summary File

Software is required to perform the following DMS services on each of the files in the ACT system.

- o Initialize File
- o Open File
- o Close File
- o Delete File
- o Store Record
- o Retrieve Record

The specific function of these DMS services and the required parameters are presented below.

The DMS service to initialize a file will be accessed the first time a file is created on disk. This service will store all appropriate file header information. The requesting routine will supply the file name and all available file header information. The DMS service routine stores the data and returns a flag to the requestor upon successful completion. If the service is unable to complete its task, a flag is returned.

The DMS services to open and close a file are requested with the file name. This will initiate the appropriate DMS service. The DMS service will perform the requested service and return a success flag to the requestor. An error flag will be returned if the file does not exist or is not closed or open, respectively.

The delete DMS service is requested with the file name to be deleted from the disk. The DMS service will delete the file and return a success flag to the requestor. An error will be returned if the file does not exist or is open.

DMS service routines which store and retrieve records are critical to the ACT System. Reducing the number of disk accesses to store, modify or retrieve data is the key to optimization of system performance. This becomes of prime importance when accessing the Feature Files and Product Specification Files.

A list of the access methods to the Feature File was presented in the design concept section of the document. The functional requirements of the ACT System which led to arriving at these access methods are the following:

- o <u>Retrieve Feature by ID Number</u>
  Feature retrieval of this type will be used extensively by those functions which process data sequentially. Additionally, random accessing of the features is desirable for those functions concerned with feature interrelationships. This random retrieval of features by ID number suggests an indexed sequential storage structure with the feature ID number as the index. The feature ID number in this context is comprised of a class, type,subtype and sequential number assigned as the features are loaded.
- o <u>Retrieve Feature by Locational Index Grid Cell</u>
  This retrieval type would be used by those functions required to determine feature interrelationships. These include all functions requiring the Coalescence Detection Service. Specification of the grid cell would be used as an index key to obtain all features located within the grid. Feature selection processing eliminates from consideration features in the grid which fail the feature

group extraction criteria. The retrieval type suggests a grid index storage structure, in which an implied grid cell mapping is imposed over the feature files. This further suggests use of a descriptive parameter with the grid index.

- Retrieve Feature by Feature Group

  This will support functions requiring the capability of wholesale feature retrieval based on feature group criteria. A feature is defined by a particular composite subset of the feature classification scheme. The feature classification is its class, type, subtype and descriptor data. Thus, a storage structure relating all features to a particular feature classification system is suggested.

- Retrieve Feature of a Feature Group Within a Certain Area

  This retrieval method will be used extensively by those functions which process given features in a given area. A retrieval of this type suggests a grid index storage structure with the descriptive data used in conjunction with the grid index. This form of retrieval will be used by functions which require knowledge of feature interrelationships within a certain area.

The index scheme must fulfill the retrieval and storage access method requirements. The previously stated concept of a "master header-segment headers" scheme influences the design of the index scheme. An analysis determined that the index scheme must encompass use of the feature ID, locational, and some descriptive information. Combination of all of these elements into one index is deemed inefficient. A preliminary index scheme has been defined.

An illustration of this indexing scheme is presented in Figure II-25. Incorporation of the feature ID, (descriptors and sequential number) and location is accomplished through the use of two index files; a descriptive feature ID index file and a grid index file. The descriptive portions of the descriptive feature ID index is the feature class, type, and subtype. This, plus a sequential feature number, serve to uniquely define each feature.

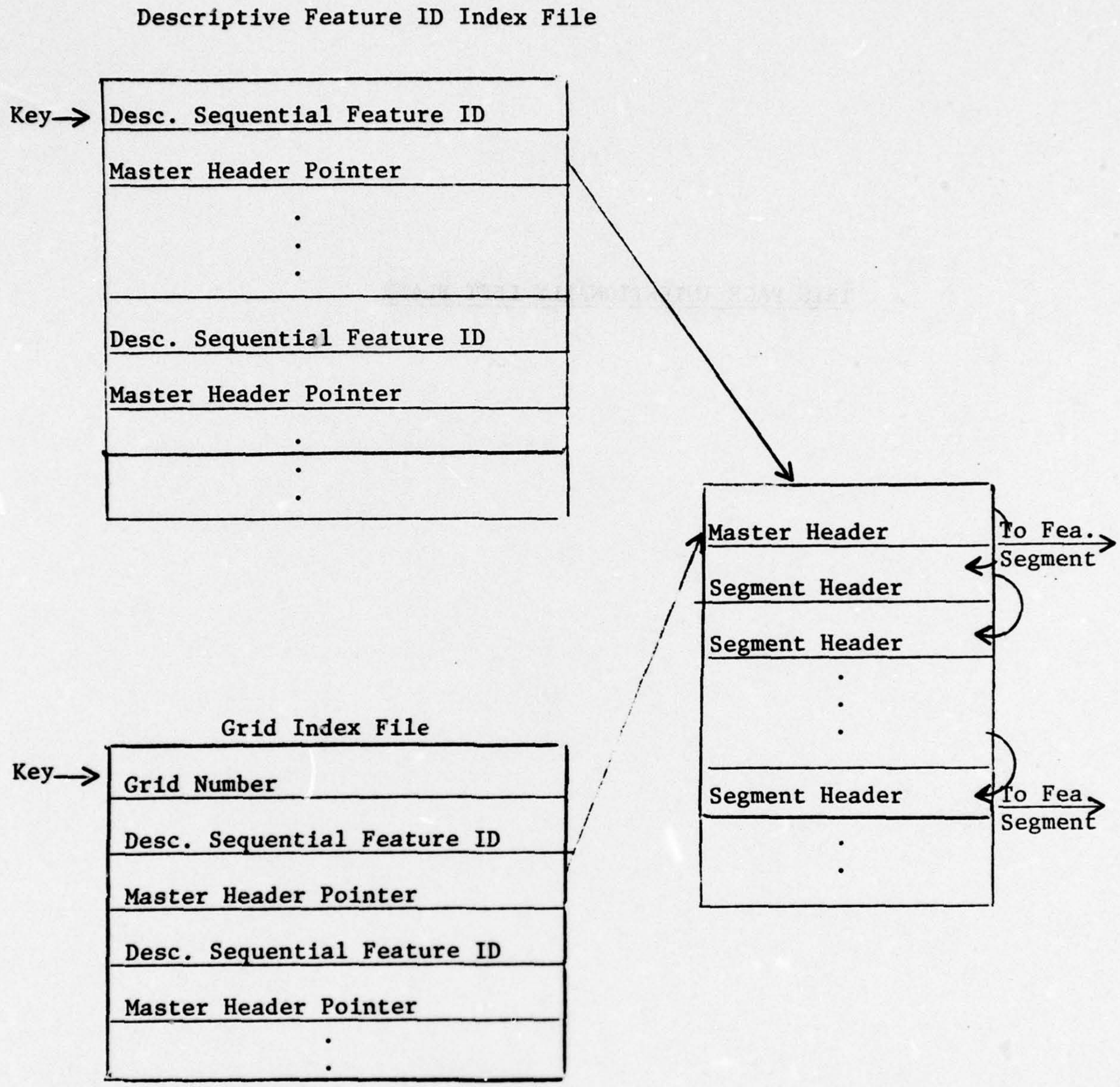

Figure II-25 Feature File Structure Concept

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A 32-bit word where the class, type, and subtype each require 6 bits (a maximum size of 63_{10}) would allow for $16,383_{10}$ sequential feature numbers. This number could be increased to $32,767_{10}$ by reducing the class field to 5 bits. The size of the class, type, and subtype fields should be chosen to allow for expansion but should not be over-sized. The size of the index key word must be selected for efficiency. This will depend on the hardware. A single word, or two words for a smaller word machine, are deemed most effective.

The grid index storage structure will permit rapid retrieval of feature by grid cell. The approach for the grid index scheme will be to impose an imaginary grid over the area represented by the file. As each feature is added to the file, the DMS will determine which grid squares are traversed by the feature. Each grid square on the chart will be mapped into a unique subspan on disk known as a grid cell. All features in the file that intersect a particular grid square will be identified in the grid cell. The DMS will maintain the grid index file (i.e., the set of grid cells) by posting all of the necessary feature identification information within the grid cell.

This model represents an optimum design to fulfill the stated retrieval requirements. The requirements of retrieval and update in conjunction with the hardware capabilities must be evaluated to arrive at the optimum file structure. There is a strong basis for the existence of two index files; a descriptive feature ID and a locational grid index. Further, the descriptive feature ID concept supports the use of an indexed sequential file using the descriptive feature ID as the key. An indexed sequential file is defined as a sequentially loaded file with an index for random access. The descriptive feature ID index would point to the master header which would in turn point to the segment headers. These then point to the feature segments. Grid pointers to all grids traversed by the features are stored in the segment headers. These segment headers would be expandable (i.e., more than one segment header per segment, to allow for an infinite number of grid pointers). Design of the grid index scheme must consider a method for recognizing and flagging features when they approach a grid boundary but do not enter the grid. In addition, area features should

contain grid pointers for the grids interior to the feature. This information is vital to accurate utilization of the index scheme. Design of this index scheme will require sophisticated data structures and DMS services.

The DMS must provide the following:

- o Initial storage of a feature
  - store feature master header
  - store feature segment header
  - store feature segments
  - update both index files
- o Storage of modified feature master header
  - restore new master header over original
- o Storage of modified feature segment header
  - restore new segment header over original
- o Storage of modified feature
  - restore feature segments
  - restore updated master header
  - restore updated segment header
  - restore new segment header(s)
  - store new feature segments
  - update both index files
  - delete original feature or feature segment as required

The service will require as input feature master header, and/or segment header, and/or data segment. Additionally, it will require the grid, feature ID, and feature class information. The DMS storage service routine will store the data as requested and update both index files. Upon successful completion, a flag is returned to the requestor; otherwise an error is returned.

The DMS retrieval routine must also be a sophisticated service. It will provide the following:

- o Retrieval of feature master header
- o Retrieval of feature segment header
- o Retrieval of feature segment

The service will be provided with the retrieval request for the desired information and the desired access method: feature ID, class, or location. The DMS service must return the requested data. If unable to do so, it will return an error flag.

The DMS storage and retrieval services will utilize the indices to the header and in turn, to the feature segment extensively to perform their task. They are the only method by which data can be retrieved from or stored on disk.

DMS storage and retrieval services must have the capabilities to access all other disk files. The access method required for the other files and their storage structure determines the required storage and retrieval DMS services.

The Data Management System must provide a method for rapid retrieval of Product Specification File (PSF) information. The software requirements and PSF contents define the access method requirements. The PSF is composed of a number of variable length entries. Three types of entries exist: product entry, function entries, and feature group entries. The product entry contains information universal to all features and all functions. Each PSF has only one product entry. A function entry contains information pertaining to an entire function. One exists for each function in the ACT System. Information in a feature group entry pertains to all features of a certain group and is required for a specific function. Both function and feature group entry types are organized by function.

The DMS must provide several methods of accessing the PSF:

- o Retrieve product entry
- o Retrieve function entry

- o Retrieve feature group entry
- o Retrieve function entry and all feature group entries for this function.

For each, the requesting routine will indicate the retrieval type desired. This must be accompanied by a function identifier when retrieving function and/or feature group entries. Retrieval of a specific feature group entry requires that the requestor identify both the function and the feature group. The DMS service will return PSF information to the requestor via one or more Product Specification Buffers. If, for some reason, the data cannot be retrieved, an appropriate error response is returned.

These requirements suggest an indexed sequential file structure. A unique index key for each entry is provided by a combination of the function identifier and feature group. Figure II-26 illustrates this structure. Key word length requirements have been discussed for the Feature File. Since both keys are a combination of a number and feature classification, the size requirements will be similar.

The Symbol and Character Library requires accessability in a random manner with the symbol or character as the indexed key. This suggests a indexed sequential file. DMS services will be required to store and retrieve each element in the file. They will be supplied the index key and the the data for storage. As with all DMS services, success or error flags are returned to the requestor.

The Compilation Summary File will contain report information. It is organized by function. All report information for a function will be grouped together. This file will be relatively small and used exclusively for reporting. A simple sequential organization will be provided. The DMS storage and retrieval services will store and retrieve data in a sequential, first in, first out manner. A retrieval request will sequentially locate the function report data requested and pass it to the requestor. Error processing will be performed.

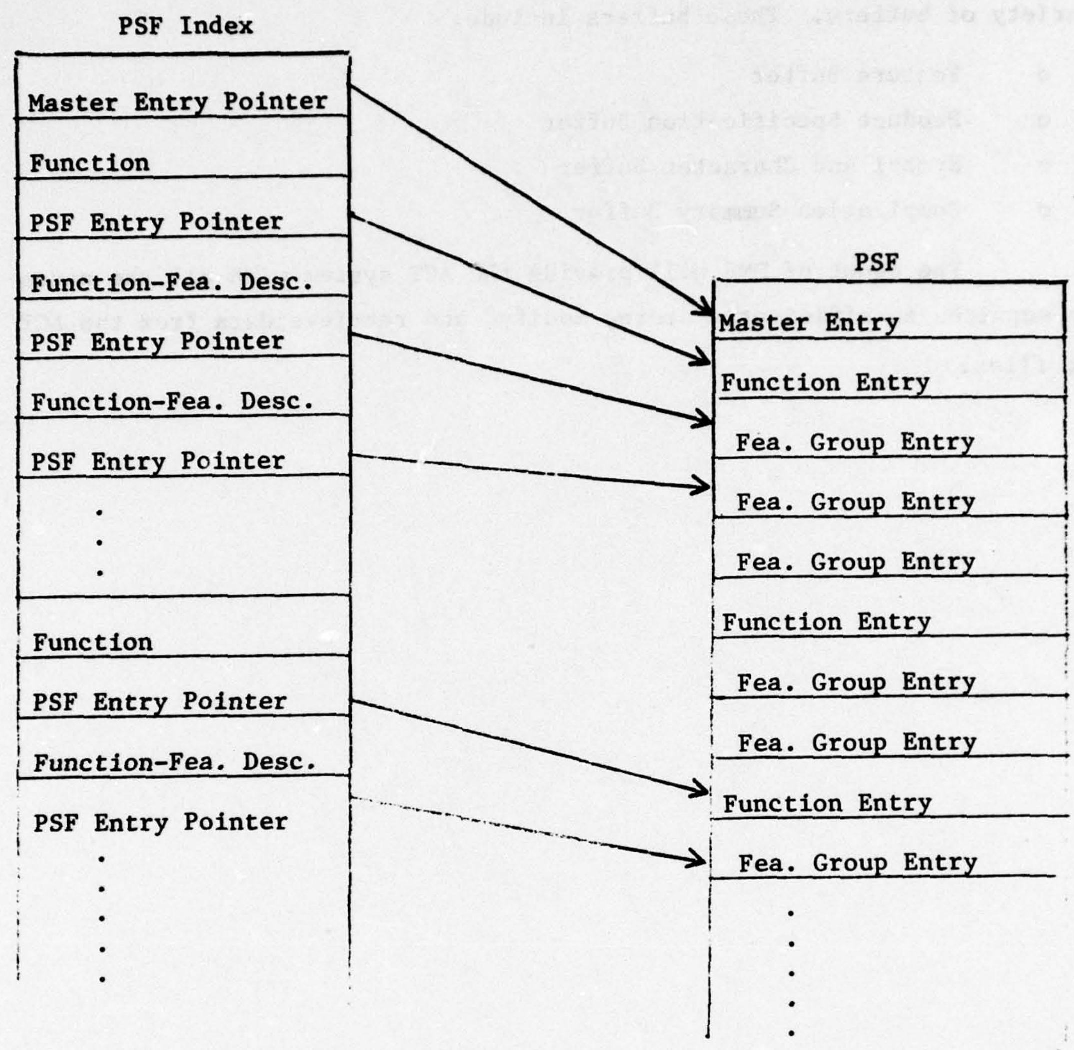

Figure II- 26 Product Specification File Structure Concept

The DMS services will receive and return data via parameters and a variety of buffers. These buffers include:

- o Feature Buffer
- o Product Specification Buffer
- o Symbol and Character Buffer
- o Compilation Summary Buffer

The gamut of DMS will provide the ACT system with all the necessary services to efficiently store, modify, and retrieve data from the ACT disk files.

7. <u>Support Services</u>

Special support services required by several functions are discussed in this section. These are unique in that they are not functions, yet are too complex to be considered DMS services. Included are:

- o User Control
- o Coalescence Detection
- o Process Reporting
- o File Summary

a. <u>User Control Service</u>

(1) <u>Purpose</u>

The User Control Service reads, validates, and interprets user input to the ACT System. This is then prepared for the other system software.

(2) <u>Description</u>

(a) <u>Input</u>

All user defined input to the ACT System is processed by this service. This information will be obtained from one or more peripheral devices (e.g., card reader, terminal). The first card input indicates the input device. The user parameters include:

- o Phase Selection
- o Function Selection
- o Sequencing
- o For each function selected
  - \- Required Input (user)
  - \- PSF Overrides
- o Process Reporting Overrides

Further description of each type of user parameter follows.

(b) Processes

The User Control Service reads the parameters listed above from the device specified by the input device indicator card. The contents and range of each are validated. A parameter identifier is followed by the user instructions. The Phase Selection parameter consists of an indicator to "select all but" or to "select only" followed by a list of the phases to exclude or include, respectively. The user may also specify default, thus selecting all phases. The Function Selection parameter is structured in the same manner as Phase Selection. It determines the functions performed during this job. Validation of selected functions insures that the associated phase has also been selected.

The complete run stream is defined by the Sequencing parameter. This may be defaulted to the standard sequence depicted in Figure II-27. This parameter consists of a phase identifier followed by a group of function identifiers. Each selected phase must be included; all included phases must have been selected. The order in which the phases are listed directs their sequencing. An entire Phase is inserted in standard sequence by specifying the phase as default. To reorder the functions within a phase, all selected functions must be listed in the non-standard sequence. All listed functions must have been selected. Any function can be specified only once. Phases may be repeated since the non-standard sequence may divide the functions of a phase (Figure II- 28). A Parameter Buffer (PB) is obtained for each occurrence of each phase. A phase identifier and a sequenced list of function identifiers are stored in the Parameter Buffer.

The fourth parameter is valid only for selected functions and must be included for each function selected. It should be ordered to correspond with the sequencing. Required input and specific criteria which must be met are defined within the individual function definitions previously included in this document. These will not be repeated here. The information provided in this parameter is used to develop parameter entries in the Parameter Buffer. These are organized by function. Each consists of

Phase I (type a)

- Input External
- Extraction
- Scale
- Line Smoothing

Phase II

- Automatic Feature Culling
- Coalescence Deletion
- Coalescence Shift
- Symbol Change

Phase III

- Automatic Type Placement

Phase I (type b)

- Output External

Figure II-27 ACT System Standard Sequencing

Phase I (type a)

Input External

Extraction

Phase II

Automatic Feature Culling

Phase I (type a)

Scale

Phase I (type b)

Output External

Figure II-28 Sample Non-Standard Sequence

"Required Input" followed by PSF Overrides. A PSF Override is composed of an indicator followed by the original and new PSF entries. The PSF is used without change by default. Each PSF Override affects only the indicated entry. The PSF remains unchanged; this parameter causes a temporary PSF modification for the current job. Occasionally, Required Input and PSF Overrides may be extensive and exceed the capacity of a single Parameter Buffer. If this occurs, the User Control Service will obtain another PB. It will be annotated as a continuation PB. All necessary information is repeated. An individual parameter defining some Required Input or a PSF Override will not span between Parameter Buffers. The exact format and length of Required Input may vary by function. Similarly, the format and length of PSF entries may vary.

Process Reporting Overrides is the final parameter. This is utilized to suppress the printed report for specific process segments. A process segment may include an entire Phase or an individual function. All are printed by default. These Process Reporting Overrides will be placed in a special purpose Parameter Buffer. This PB contains a unique Process Reporting identifier in place of the phase and function identifiers. No PB is required when this parameter is defaulted.

Following validation, interpretation, and storage of all user input, the Parameter Buffers are returned to the requesting routine. These are accompanied by a service completed indicator. Error conditions are recognized and the requestor notified. Figure II-29 illustrates the data flow of this service.

(c) Output

The User Control Service produces a series of Parameter Buffers. These indicate the functions to be performed and their sequence. In addition, the Parameter Buffers contain validated user input.

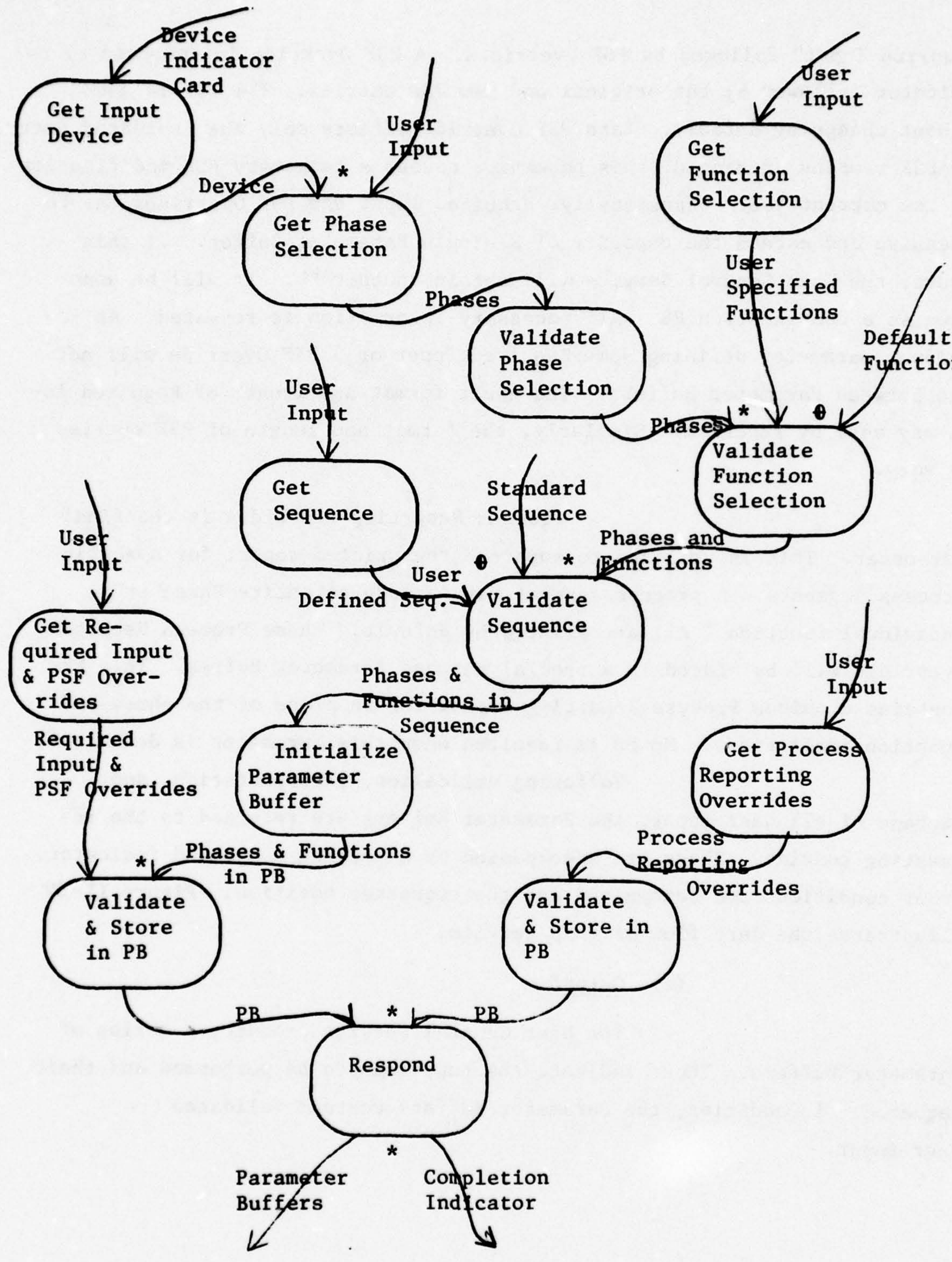

Figure II- 29 User Control Service Data Flow Graph

(d) Performance Objectives and Processing Variables

This service provides an effective vehicle for communication between the system user and the ACT system. As such terminology should be user oriented. Proper error detection at this stage will eliminate more complex error conditions which might be encountered by more sophisticated software components.

The capability to accept input from more than one device has been specified. Subsequent addition of other devices will be facilitated by an initial modular design. Thus, input is read and formatted (i.e., blocked) by a module and is verified and stored by a common routine. One envisioned augmentation is an interactive service, where the user is queried to obtain the necessary parameters.

b. Coalescence Detection

(1) Purpose

Coalescence Detection is the process of locating a common (set of) point(s) belonging to two or more features. Points falling within a given tolerance distance are also considered to coalesce.

(2) Description

(a) Input

A Feature Buffer containing a feature master or segment header is provided by the requesting routine. Additional input is received from the ACT Indexed Feature File (IFF) and via a Product Specification Buffer. This PSB shall include the feature classifications with which coalescence is to be detected and the associated coalescence tolerances and feature line weights. Area feature types will be indicated. A specific subarea to be considered is annotated and the subarea defined. Certain indicators or pointers are also supplied. These include:

- pointer to current locational index grid cell within the primary feature header list
- pointer to current candidate feature classification
- indicator to detect any coalescence or all coalescences with primary feature
- new primary feature indicator

(b) Processes

The Coalescence Detection Service will locate a coalescence between two features, referred to as the primary and candidate features. The input Feature Buffer contains a header for the primary feature. Appropriate portions of the feature are processed, depending upon the type of header input, the entire feature for master header, or a feature segment for segment header. These primary features are input sequentially, by ascending identifier. This service must obtain a coalescence candidate feature and search for coalescence. It then either responds to

the requesting routine or repeats the above processes until a coalescence is located or all candidates have been exhausted.

The current locational index grid cell identifier is obtained from the primary feature header. This grid cell must fall within any chart subarea specified. If it does not, the service proceeds to the next grid cell in the header list. When all grid cells have been processed, a response indicating no coalescence detected is returned to the requesting routine. If the grid cell is considered, the current candidate feature classification and associated coalescence parameters (e.g., tolerance) are obtained from the Product Specification Buffer (PSB). A candidate feature is then retrieved from the ACT Indexed Feature File (IFF) via the DMS service to retrieve feature within grid cell and by group. The initial request is indicated as such. All subsequent requests in the same cell for the same feature classification are requests for next feature in cell and of group. The candidate identifier is examined to insure that this feature has not previously been a candidate for this primary feature. Similarly, the feature identifier for a valid candidate must be a larger number than the primary feature identifier. When no valid candidate is located, the next candidate feature classification in the PSB becomes current and the above process is repeated. This continues until all candidate feature classifications have been considered. The next locational index grid cell then becomes current and the above processes are repeated. Thus, all grid cells traversed by the primary feature are considered and, within each grid cell, each candidate feature classification is considered. Sequential primary feature processing and candidate identifier examination procedures insure that a candidate is considered only once for any primary feature.

Once a candidate feature is obtained, it must be examined for coalescence with the primary feature. This requires retrieval of the data points for each feature via the DMS service. The search for coalescence is then performed. Special consideration is afforded to area features. If a coalescence is detected, it is traced to its end. The start point, end point, and length of coalescence are recorded. When any coalescence is requested, this information is immediately returned to the requestor and the service terminates. Otherwise, the search continues until a feature

endpoint is reached. Similarly, the features are searched their entire length even if no coalescence is detected. This search does not require examination of each data point since the grid cell indicators in the feature segment header can be utilized. Once these features have been processed in this manner, they never again need be examined for coalescence with each other. The requestor is notified of all coalescences detected and the service terminates. If none were found, the service proceeds to the next candidate by the methods described above. Error conditions are recognized and processed. Figure II-30 illustrates the data flow of the Coalescence Detection Service.

(c) Output

This service returns a coalescence or no coalescence indicator to the requesting routine. The former is accomplished by returning the start point, end point, and length for each coalescence detected. This also serves to indicate to the requestor that the detection process for primary feature and this candidate is completed, although there may be other candidates which also coalesce with this primary. Consequently, the grid cell and candidate classification indicators must be maintained to detect these other coalescences. The no coalescence response indicates to the requestor that all coalescences have been located for this primary. Thus, the grid cell and candidate classification indicators can be reinitialized. Similarly, the next primary can be processed.

(d) Performance Objectives and Processing Variables

This service efficiently and accurately detects feature coalescence. The Product Specification Buffer (PSB) contains the coalescence parameters. This PSB is defined from the PSF and user override parameters. Thus, the user retains ultimate control over the process and the service remains free of internal constraints. Its utility arises from this independence from parameters. Similarly, the purpose of this service may be altered via the parameters. For example, this service becomes intersection location when applied to certain feature classifications and illegal coalescence detection when applied to others. Its use may also vary considerably. One parameter set is provided to detect illegal feature conflicts,

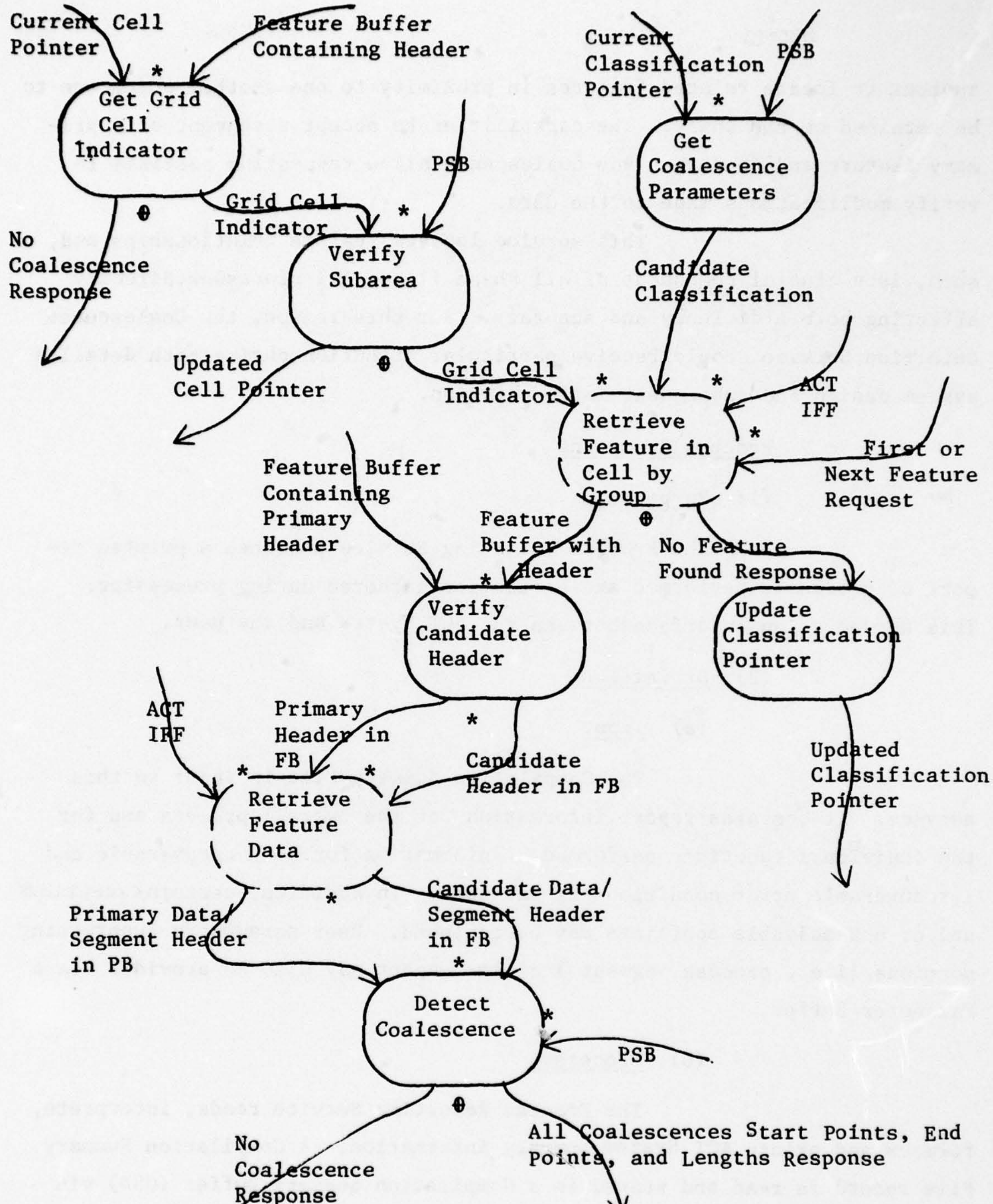

Figure II- 30 Coalescence Detection Data Flow Graph

another to locate related features in proximity to one another which are to be retained on the chart. The capabilities to accept a segment of a primary feature and to detect any coalescence allow requesting routines to verify modifications made to the data.

This service locates feature relationships and, as such, is a crucial component of all Phase II and III processes, directly affecting both efficiency and accuracy. For this reason, the Coalescence Detection Service should receive particular attention during both detailed system design and subsequent implementation.

c. Process Reporting

(1) Purpose

The Process Reporting Service produces a printed report of processes performed and statistics gathered during processing. This serves as an interface between the ACT System and the user.

(2) Definition

(a) Input

The Compilation Summary File is input to this service. It contains report information for the overall process and for the individual functions performed. Information for both recoverable and irrecoverable error conditions is included. In addition, certain exceptions and/or unresolvable conflicts may be included. User parameters suppressing portions (i.e., process segments) of the report may also be provided via a Parameter Buffer.

(b) Processes

The Process Reporting Service reads, interprets, formats and prints ACT System summary information. A Compilation Summary File record is read and stored in a Compilation Summary Buffer (CSB) via the DMS service. Each record or set of records contains information for a specific process segment. This service examines the CSB to determine which process segment information it contains. This information is formatted

properly; the format for different process segments may or may not be the same. Compilation Summary File process segments include:

- o Irrecoverable Errors
- o ACT System
- o Phase I
  - Input External
  - Feature Extraction
  - Scale
  - Line Smoothing
  - Output External
- o Phase II
  - Automatic Feature Culling
  - Coalescence Deletion
  - Coalescence Shift
  - Symbol Change
- o Phase III
  - Automatic Type Placement

The overall report format will distinguish between these segments. Null segments may be omitted or indicated as not performed. Segments are also omitted according to user parameters. No other process segment information is printed on the page reporting unrecoverable errors. Each process segment includes process statistics, recoverable error information, exception information and unresolvable conflict information. Control is returned to the requesting routine after the entire Compilation Summary File has been processed and printed. Recoverable errors are identified and printed at the end of the report. Unrecoverable errors cause the Process Reporting Service to abort and return control to the requesting routine. Figure II-31 illustrates the data flow of this service.

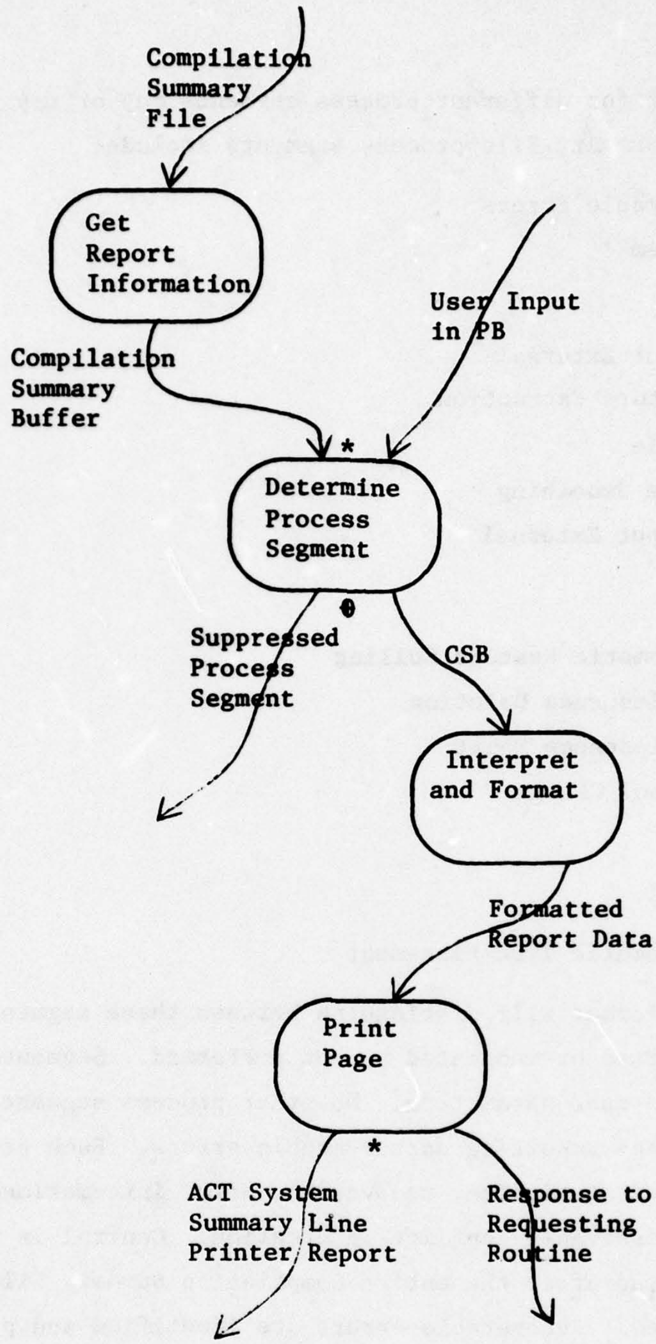

Figure II- 31 Process Reporting Data Flow Graph

(c) Output

This service produces an ACT System summary line printer report. A success or error flag is returned to the requesting routine.

(d) Performance Objectives and Processing Variables

The report produced by this service conveys to the ACT System user what has been done, how it was done, and what specific problems were encountered for the ACT System processing just completed. As such, this report is crucial to the utility, interpretability, and effectiveness of the system.

d. File Summary

(1) Purpose

The File Summary Service provides data file characteristics and statistical information to the ACT System user. This is intended as an aid to job preparation, monitoring, and evaluation.

(2) Description

(a) Input

A Feature Buffer containing a feature header or data record is input to this service. The initial request is accompanied by user guidelines. The first and final requests are uniquely identified.

(b) Processes

All accumulation areas are initialized on the first request to this service. Several forms of information are gathered. Each feature is examined and appropriate values are updated. Upon receiving the final request, the gathered information is formatted and a printed report generated.

Each report contains information geared towards a specific form of analysis performed by the user. In many cases, similar information (e.g., total number of features) is contained. Types of information gathered by this service includes, but is not limited to:

- o chart data
  - bounds
  - projection
  - size
  - resolution
  - history (i.e., source)
  - scale
  - source scale(s)

- o feature data
  - total number features
  - total number features per class, type, subtype
  - total number area, lineal, point features
  - density for all features
  - density per class, type, subtype
  - density per area, lineal, point features
  - total number data points
  - average feature smoothness
  - average feature length or area
- o process data
  - total number candidates possible per function
  - total number conflicts possible per function

The user retains control over the information produced. A default option will generate a yet to be determined set of statistics. Density will be expressed as lineal inches per square inch. All feature headers for a given classification can be printed. Appropriate information is updated in the Compilation Summary Buffer. Any error conditions are recognized and the requesting routine notified.

(c) Output

The File Summary Service produces a printed report conveying data file characteristics. Upon completion, the requesting routine is notified via a task successful indicator.

(d) Performance Objectives and Processing Variables

The File Summary Service, by gathering and printing data file statistics relays data file characteristics to the ACT System user. A modular design should be employed so that software to generate additional information can readily be incorporated.

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APPENDIX A
SAMPLE PRODUCT SPECIFICATION FILE CONTENTS

This appendix consists of examples of Product Specification File contents. The ACT System software requirements define the types of information necessary. Actual contents are defined from existing production specifications.

FUNCTION	REQUIRED PSF INFORMATION
Input External	None.
Feature Extraction	Classifications to be deleted/retained (See Feature Culling).
Scale	Product scale.
Line Smoothing	Preferred data point resolution Algorithm and parameters per classification.
Output External	None.
Automatic Feature Culling (See Table 1)	Feature classifications to delete/accept. For each classification, criteria which must be met to delete/accept. Parameters necessary to define these criteria. Classifications which may be replaced with a point or area symbol upon deletion.
Coalescence Deletion (See Tables 2 & 3)	For each feature classification, other classifications with which coalescence is illegal and may be resolved via deletion. Minimum length of coalescence segments processed, based on classification. Criteria and associated parameters to determine which feature is modified.
Coalescence Shift (See Tables 2 & 3)	For each feature classification, other classifications with which coalescence is illegal and may be resolved via shift. Minimum length of coalescence segments processed, based on classification. Criteria and associated parameters to determine which feature is modified. Direction of shift. Minimum separation required to resolve coalescence. Maximum shift tolerance.
Symbol Change	Area feature classifications which may become point symbols. For each area feature classification, the parameters which must be met (exceeded) for the feature to be represented by a point symbol. The desired symbology for each area feature classification.

FUNCTION	REQUIRED PSF INFORMATION
Symbol Change (Cont'd)	Feature classifications which are considered closed. For each feature classification symbolized, the related feature classifications which may require modification. For each related feature classification requiring modification, the criteria to be met, the type of change to be made and associated parameters.
Type Placement	The feature classifications which require text for each classification, the location of textual information within the feature descriptors. For each classification, text orienation relative to the feature. Distance and direction of displacement of the adjacent text start point from the feature (centroid point). Classifications for which conformal text should be repeated, and the repeat interval (distance along feature). Placement parameters. Classifications with which text may not coalesce.

Feature Classification \ Retention Criteria	Always Retain	Feature Type	Feature Size	Significance	Culture Type	Culture Density	Road Network	Railroad Network	Terrain	Drainage	Never Retain
HYDROGRAPHY											
Shorelines	⊠										
Lakes & Ponds			⊠							⊠	
Reservoirs	⊠										
Streams - Primary		⊠	⊠							⊠	
- Secondary			⊠							⊠	
- Tertiary			⊠							⊠	
Falls		⊠									
Aqueducts				⊠							
Flumes, Penstocks	X	O									
Canals	X			O							
Artificial Bodies of Water		O	X								
Springs, Wells, Waterholes		X	O								
Fish Ponds, Hatcheries	O										X
Rapids		⊠									
Ditches	X	O									
Marsh, Swamp			⊠								
Kanats		O									X
Peat Bog, Peat Cutting			⊠								
Cranberry Bog	X	O									
Salt Evaporators		O	X								
Rice Fields	X	O								⊠	
Wades, Sebkra											

More than one criteria may apply as shown

Legend:
X JOG
O ONC
⊠ both

Table II-1 Feature Culling Production Specifications (Page 1 of 10)

Feature Classification \ Retention Criteria	Always Retain	Feature Type	Feature Size	Significance	Culture Type	Culture Density	Road Network	Railroad Network	Terrain	Drainage	Never Retain
COASTAL HYDROGRAPHY											
Foreshore Flats	X		O								
Reefs, Ledges	⊠										
Rocks	O	X									
Foul Ground, Shoals		⊠									
Wrecks		⊠									
Sunken Dangers		⊠									
Depth Curves	X										O
Breakers		⊠									
Kelp		X									O
Maritime Limits		X									O
Sand Bars		⊠									
Anchorage		X									O
Weirs		O									X
Soundings				X							O
Bottom Characteristics	X										O

Table II- 1 Feature Culling Production Specifications (Page 2 of 10)

Feature Classification / Retention Criteria	Always Retain	Feature Type	Feature Size	Significance	Culture Type	Culture Density	Road Network	Railroad Network	Terrain	Drainage	Never Retain
HYPSOGRAPHY											
Contours - Basic	⊠										
- Intermediate	⊠										
Ridge Lines	O										X
Levees				⊠							
Fault Scarp											⊠
Spot Elevation		⊠		⊠							
Control Point	X										O
Benchmark, Pass Point	⊠										
Glacier	⊠										
Moraine	X	O									
Nunataks, Ice Peaks	⊠										
Pack Ice, Snowfield	⊠										
Ice Shelf	⊠										
Ice Cliffs	X			O							
Esker				⊠							
Area Mining Features	X		O								
Karst, Lava Flow			X	O							
Sand Area			X	O							
Sand Dunes	X			O							
Rock Outcrop			X	O							
Gravel Area	X			O							
Sand Ridge			X	O							
Volcano, Craters	O		X								
Cave	X										O
Mountain Passes	X			O							
Cuts and Fills				O							X

Table II-1 Feature Culling Production Specifications (Page 3 of 10)

Feature Classification \ Retention Criteria — RAILROADS	Always Retain	Feature Type	Feature Size	Significance	Culture Type	Culture Density	Road Network	Railroad Network	Terrain	Drainage	Never Retain
Main Line	⊠										
Branch		⊠	⊠			⊠					
Siding		X				O					
Spur		X	X			⊠					
Rail Yard			⊠			O					
Railroad Stations						⊠					
Snowshed		⊠									
Car Lines, Tramways		⊠									
Non-Operating		O									
Dismantled		⊠									
Destroyed		O									
Proposed											⊠
Size and number of tracks	X										O
Name						X					O

Table II-1 Feature Culling Production Specifications (Page 4 of 10)

Feature Classification / Retention Criteria ROADS	Always Retain	Feature Type	Feature Size	Significance	Culture Type	Culture Density	Road Network	Railroad Network	Terrain	Drainage	Never Retain
Hard Surface-Dual Lane	☒										
- Primary			☒				☒				
Loose/Light Surface-All Weather			☒				☒				
- Fair Weather			☒				☒				
Fire Road		X	O				O				
Lumber, Wood Road		X	O				O				
Dirt Road			☒				☒				
Cordutoy Road		X	O				O				
Unknown Surface			☒				☒				
Cart Track			X				☒				
Foot Path (Trail)			X				☒				
Private		X									
Proposed											☒
Abandoned		X									O
Road Markers	X										O
In Pop.Place-Through Road	X										O
-Secondary Road			X				X				O
Lane Width (greater than 2)		X					X				O
Names							X				O
Objectives	X										O
Distances			X								O

Table II-1 Feature Culling Production Specifications (Page 5 of 10)

CULTURAL FEATURES (Feature Classification / Retention Criteria)	Always Retain	Feature Type	Feature Size	Significance	Culture Type	Culture Density	Road Network	Railroad Network	Terrain	Drainage	Never Retain
Open Pit Mines		⊠				X					
Quarries, Tailings	X	O									
Strip Mines, Mine Dumps		O	X								
Power LInes	⊠										
Telephone & Telegraph Lines		⊠									
Pipelines		⊠									
Dams	⊠										
Locks, Sluice Gates		⊠									
Jetties, Weirs	X					O					
Piers, Wharfs, Docks, Sea Walls	⊠										
Walls, Trenches, Fences		⊠									
Lookout Towers	O	X									
Forts, Stadiums, Racketracks,Ruins		⊠									
Cemetaries											O
Non-Water Wells	⊠										
- Abandoned		⊠									
Tanks		⊠									
Non-Water Reservoirs	O		X								
Silos		⊠									
Grain Elevators	O	X									
Bridges, Viaducts, Tunnels	⊠										
Footbridges				O			X				
Over-Underpasses			X	O			O	O			
Traffic Circles			X								
Ferries-Vehicle	X			O							
-Pedestrian				O			X				

Table II- 1 Feature Culling Production Specifications (Page 6 of 10)

Feature Classification / Retention Criteria	Always Retain	Feature Type	Feature Size	Significance	Culture Type	Culture Density	Road Network	Railroad Network	Terrain	Drainage	Never Retain
CULTURAL FEATURES (Cont'd)											
Fords - Roads	X			O							
- Trails							X				O
Power Line Pylons	X										O
Lighthouses	X	O									
Control Points	X										O

Table II- 1 Feature Culling Production Specifications (Page 7 of 10)

Feature Classification / Retention Criteria — POPULATED PLACES	Always Retain	Feature Type	Feature Size	Significance	Culture Type	Culture Density	Road Network	Railroad Network	Terrain	Drainage	Never Retain
Cities		■			■	■					
Towns and Villages		■			■	■					
Kampongs	X		O		■	■					
Proposed											O

Table II-1 Feature Culling Production Specifications (Page 8 of 10)

Feature Classification / Retention Criteria: PERENNIAL VEGETATION	Always Retain	Feature Type	Feature Size	Significance	Culture Type	Culture Density	Road Network	Railroad Network	Terrain	Drainage	Never Retain
Woods (Forest, Jungle)		O	X								
Orchards, Vineyards		O	⊠								
Tropical Grass		O	X								
Mangrove		O	X								
Nipa		O	X								
Tundra		O									
Scattered Trees		O	⊠								
Clearings		O	X								
Park Areas			O								
Hedge Rows											⊠
Oases	O										

Table II-1 Feature Culling Production Specifications (Page 9 of 10)

Feature Classification / Retention Criteria	Always Retain	Feature Type	Feature Size	Significance	Culture Type	Culture Density	Road Network	Railroad Network	Terrain	Drainage	Never Retain
BOUNDARIES											
International	⊠										
State, Provincial	X	O									
Occupancy Zones	⊠										
De Facto	⊠										
Date Line	O										
Convention, Mandate	⊠										
Reservations		O									
Division of Insular Sovereignty	⊠										

Table II-1 Feature Culling Production Specifications (Page 10 of 10)

FEATURE		FEATURE	
Stream - primary		Stream - secondary	D
- primary		- tertiary	D
- secondary		- tertiary	D
Aqueduct		Levee	D
Aqueduct	D	Road	
Aqueduct		Any overpassed feature	D*
Pipeline		Any overpassed feature	D*
Flume or Penstock		Any overpassed feature	D*
Salt Evaporator		Levee	D*
Marsh and Road		Levee	D
Bog and Road		Levee	D
Rice Field		Levee	D*
Contour - Index		Contour - Intermediate	D*
- Intermediate		- Intermediate	D*
Contour Ticks		- Intermediate	D*
Levee		Contour	D*
Levee	D	Road	
Levee	D	Railroad	
Nunatak		Snow or Ice	D
Pop. Place Boundary	D*	Pop. Place Boundary	D*
Pop. Place Boundary	D*	Wall	
RR-Narrow Gauge	D*	RR-Normal or Broad Gauge	
RR-Dismantled	D*	Road	
RR-Main Track	S	RR-Siding	S
Pop. Place		Car Lines	D*
Road		Car Lines	D*

Legend: D Delete; S Shift; * Segment Only

Action is noted following feature it will be performed on.

Table II- 2 Coalescence Deletion/Shift JOG Production Specifications (Page 1 of 2)

FEATURE		FEATURE	
Snowshed		RR	D*
Bridge and Road		RR	D*
Causeway Shoreline	D*	Road	
Overpass		Overpassed Feature	D*
Pipeline	D*	Road (or Trail)	
Pop. Place		Powerline	D*
Boundary	S	Road	
Boundary	S	Shoreline	
Boundary	S	Coastal Water	
Pop. Place		Road Lane Information	D
Levee		Cart Track	D*
Depth Curve	D*	Any Feature	
Road Casing		Vegetation	D*
Bridge		Stream	D*
Viaduct		Stream	D*
Pop. Place		Telephone & Telegraph Lines	D*
Boundary	D*	Track	
Boundary	D*	Trail	
Stream	S	Road	S
Road	S	RR	S
RR	S	Stream	S
Levee		Trail	D*

Table II- 2 Coalescence Deletion/Shift JOG Production Specifications (Page 2 of 2)

FEATURE		FEATURE	
Island		Island	D
Coastline		Island	D
Reservoir		Woods	D
Stream - primary		Stream - secondary	D
- primary		- tertiary	D
- secondary		- tertiary	D
Aqueduct		Levee	D
Aqueduct (and Levee)	D	Road	
Aqueduct		Any Overpassed Feature	D*
Pipeline		Any Overpassed Feature	D*
Glacier		Shoreline	D*
Dismantled RR	D	Road	
Bridge		Road	D*
Bridge		RR	D*
Bridge and Road		RR	D*
Road		Causeway Shoreline	D
RR		Causeway Shoreline	D
Shoreline		City Outline	D*
Double Line Stream		City Outline	D*
RR		City Outline	D*
Walls	D	City Outline	
Any Lineal Features		Kampong Outline	D*
Tracks, Trails	D	Kampong	
Mine		Mine	D
Dam	S	Road	
Coastline	D*	Sea Wall	
Woods	D*	Dual Lane Road	
Contour - Index		Contour - Intermediate	D*
- Intermediate	D*	- Intermediate	D*
Dam		Shoreline	D*

Table II- 3 Deletion/Shift ONC Production Specifications

APPENDIX B

GLOSSARY OF STANDARD TERMINOLOGY

Advanced Compilation Techniques (ACT) System - the system defined by this design specification.

Compilation Summary File (CSF) - contains all statistics accumulated during ACT processing.

Compilation Summary Buffer (CSB) - contains a CSF record.

Data Management System (DMS) - group of services accessing and regulating all data files.

Feature Buffer (FB) - contains one ACT standard system format feature record.

Feature File (FF) - consists of all ACT standard system format data features on disk or magnetic tape.

Indexed Feature File (IFF) - consists of the FF accessible via both locational and descriptive index schemes.

Parameter Buffer (PB) - contains all selection and sequencing information and all user input for a phase (or a function).

Product Specification File (PSF) - consists of all guidelines and parameters required for the batch compilation process.

Product Specification Buffer (PSB) - consists of all user input and PSF information required for a function. (PSF information is updated by user overrides.)

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